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Edited by

Lewis Stephen Pilcher, M D , LL D , *of New York*

Associate Editors

W Sampson Handley, M S , M D , F R C S , *of London*

James Taft Pilcher, B A , M D , *of New York*

Walter Estell Lee, M D , *of Philadelphia*

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LEWIS STEPHEN PILCHER

A BIOGRAPHICAL PICTURE OF A MASTER OF MEDICAL
LITERATURE^{*}

By JAMES PETER WARBASSE, M.D.

OF BROOKLYN NEW YORK

SOCIETY progresses only as its unique characters point the way, and lead. Every age, every nation, every community has its outstanding figures in medicine who create standards and from whom the profession takes its cue. To the credit of medicine these have been the consummate flower of the civilization of their time. Charaka, Hippocrates, Aretaeus, Pare Harvey, Sydenham, Haller, Hunter, Servetus, Holmes, and Gross are the names of unique personalities. The world recognized them as good doctors, but it well might have chosen them as its moral and intellectual guides. Their lives were exemplary. It is such as these whom medicine has saluted as its leaders in thought and action. They have differed from those in other professions and crafts: their characters have been made superb by their faith in science.

The quality of uniqueness is not concealed. It is patent and obvious. When Lewis Stephen Pilcher entered the University of Michigan at the age of thirteen, and took his bachelor's degree at seventeen, he did the unique thing. He still stands today, at the age of eighty-nine, the youngest matriculant and the youngest graduate of that great institution. His master's degree was added within a year, and in that same year he entered upon medical study. This was in 1863 when the Civil War was raging. The next year found him with enough medical knowledge to volunteer as a hospital steward and throw himself into the thick of service to the sick and wounded. This was the beginning of his medical experience—seventy years ago.

Then back to the University of Michigan and the doctor's degree in 1866. Many years later, 1900, this same institution conferred upon him the further honorary degree of Doctor of Laws. Practice began in a rural district of Michigan at the age of twenty, at the same time, to guarantee a live-

^{*} A tribute by the publishers of the ANNALS OF SURGERY to its Editor, prepared at their request by JAMES P. WARBASSE, M.D., of Brooklyn, N. Y., the former Hospital Interne, later Associate Surgeon, and long time friend of its subject.

hood, teaching in the little schoolhouse by the blacksmith shop. He rode his horse across the countryside to the call of the sick, followed the current literature of medicine, and for diversion read the classics in their original Greek and Latin.

This was practice backed by the rich experience in the hospitals at the front and on the battlefield, such as had made the Surgeons of the Long Robe of the School of Saint Côme wonder how the young Ambroise could know so much. When the youthful Lewis left the schoolteacher's desk and sallied forth mounted and caparisoned, with wisdom in his head, experience at his finger tips, and succor in his saddle bags, it was a veritable Sir Galahad of medicine who bestrode his steed, and the quest was the grail of learning. He rode at times as far as fifty miles away. Thinking, too, was one of the opportunities offered by the long silences of country practice in those pioneer days.

However, the broken legs and arms and the ills of country folks were not enough. Already he had out his lines for wider fields. The next move was to an internship in a Detroit Hospital. Then a post-graduate course in the hospitals of New York City. And then came the successful examination and appointment as Assistant Surgeon in the United States Navy, in 1867. He sailed the seas, got experience with practice and with people, and read voraciously. In 1869 yellow fever broke out on the wooden sailing frigate *Salatoga* in Havana harbor. The surgeon of the ship was one of the first to die of the disease. Upon his death, in his place, the young Assistant Surgeon Pilcher was sent from another ship to the stricken vessel. With her infected crew she started for northern waters. By the time she reached New York and was relieved, thirty-seven cases of the disease had developed, seventeen of whom died. Then the Assistant Surgeon also came down with yellow fever and was removed to the Naval Hospital at Brooklyn. His recovery, the "Lady of the Flowers," his marriage, retirement from the Navy, and entrance into private practice, in 1872, all spelled romance and adventure.

Then came the years of practice. And practice is what most doctors do. But Pilcher wanted something more. It was the eternal hunger for perfection. He organized a dissecting room in his house. This expanded into an adjacent building. A museum and library grew up in connection with it. He dissected also at the Long Island College, and became Adjunct Professor of Anatomy, in 1879, and Surgeon to the Dispensary. In 1885 he was appointed Professor of Surgery at the New York Post Graduate Medical School.

Out of the private dissecting room grew something significant. Here assembled a select group of ambitious young men like himself. They became the Brooklyn Anatomical and Surgical Society, in 1878, with Pilcher

as president Their meetings were serious and their discussions on a high plane of scientific thought Their Transactions were published as the *Annals of the Anatomical and Surgical Society* The first volume bears the date of 1878-9 The next year the transactions were issued as the *Annals of Anatomy and Surgery*, a monthly periodical, under Pilcher's editorship This continued till 1884, in which year he went to Europe for special study in surgery When he returned, the publication was continued as the ANNALS OF SURGERY with Pilcher as Editor, which position he has occupied to the present day This publication, beginning in 1884, was acquired in 1897 by J B Lippincott Company The editorial policy and censorship of advertising have never been relinquished by the Editor If we add to the fifty years of the ANNALS OF SURGERY, the seven years of the *Annals of Anatomy and Surgery*, and its predecessor which he inspired and dominated this period of medical editorship establishes him as the dean of living medical editors in the United States, if not in the world Medical editors have been born served long editorial periods, and died, while this dean of surgical journalism continues to sit at his desk

The ANNALS OF SURGERY was the first surgical journal in the English language It has been guided continuously by a single hand It has always reflected its editor's standards of quality Dignified, sincere, scientific, it has maintained its excellence Accepted as the official organ of the American Surgical Association, the New York Surgical Society, and the Philadelphia Academy of Surgery, it has profoundly influenced American surgery It has inspired a high quality not only in surgical journalism but in surgical practice as well It has for fifty years steadfastly kept the faith as a true monthly review of surgical science and practice And for this, medicine owes a debt to this one man

The quality supremely lacking in the run of mortals is the ability to make decisions The man possessed of this quality moves forward if he have but moderate intelligence When this gift is combined with a high intelligence and learning, a dominant and influential character is the result This is Pilcher He makes decisions There is never any question about where he stands He has no difficulties in expressing himself because he is never in a state of vacillation And he has had much to say, and he has said it The first contribution from his pen was published in 1871, it chronicled hospital observations Since that time the literature has been enriched by his monographs and books

When the Methodist Episcopal Hospital of New York was contemplated, the leaders of the church called upon Pilcher for his surgical skill and organizing ability His vision and genius made that institution a surgical centre of note From its beginning, in 1885, until 1907, his was the dominating personality, demanding always excellence and scientific stand-

ards of the highest. When the methods of the hospital departed from his conception of those standards, his resignation from the Staff and the Board of Directors was prompt and unequivocal.

Connected with several other institutions and with his own private hospital, his work expanded. His contributions to the literature of surgery have been voluminous. His *Treatment of Wounds* gave him prestige in Europe on his first surgical pilgrimage. His love of learning took him among the masters of his craft. He collected the classics of surgery. In 1918, after forty years of medical bibliophilia, he published a quarto volume of two hundred pages, an *Et Libris Antiquarius*, which was a descriptive catalogue of the works of the old masters in his private library. Here was a goodly number of *incunabula* published within the century in which Columbus discovered America. These products of the printer's art stand today stalwart and erect while the books of more learned times droop and decay. The love of these sturdy volumes is peculiarly a medical quality, symbolical of the medical mind and its appreciation of health in books. This choice library he donated to the University of Michigan, where it enjoys special housing as the Pilcher Medical Library.

Honors without number have expressed the esteem of medicine and learning. Doctor Pilcher was President of the New York State Medical Society in 1892 and of the Medical Society of the County of Kings in 1900. He is a Fellow of the American Surgical Association, and was its President in 1918, Honorary Fellow of the American College of Surgeons, the Philadelphia Academy of Surgery, the College of Physicians of Philadelphia, the New York Surgical Society and the Brooklyn Surgical Society, and one time Commander-in-Chief of the Grand Army of the Republic.

In 1916, the semicentennial of his practice was celebrated by a public assembly. He was presented with a massive gold medal, a silver replica of which is deposited in the Metropolitan Museum of Art. A *Festschrift* surgical volume in his honor was issued at the time. Expressions of appreciation were published in another volume.

His autobiography, entitled *A Surgical Pilgrim's Progress*, published in 1925, is a charming record of a life rich in satisfactions. Retired from active surgical work, he still continues the editorship of the *ANNALS OF SURGERY* as a congenial joy.

I write as an intimate friend and long-time associate of Doctor Pilcher. I know that he has exerted an influence for good upon a multitude of physicians beyond his ken. His scholarship ornaments a rare professional life. His character stands as a stalwart challenge to his profession. The debt that medicine owes to him can be paid only by continuous homage to the qualities he exemplifies.

JAMES PETER WARBASSL

THE DISRUPTION OF ABDOMINAL WOUNDS WITH THE PROTRUSION OF VISCERA¹

BY FRANK L. MILLIN, M.D., AND EDWARD L. HOWES, M.D.
OF NEW YORK, N. Y.

FROM THE SURGICAL SERVICE OF THE PRESBYTERIAN HOSPITAL AND THE SURGICAL DEPARTMENT OF THE COLLEGE OF
PHYSICIANS AND SURGEONS, COLUMBIA UNIVERSITY, NEW YORK

The disruption of abdominal wounds with protrusion of viscera is a post-operative accident accompanied by such distressing symptoms and high mortality that it warrants most careful consideration to determine, if possible, whether it is avoidable or unavoidable. Sokolov¹ analyzed the replies which he received from over a thousand questionnaires sent out to surgeons all over Europe and concluded that the incidence ranged from 2 to 3 per cent of all abdominal operations. We frankly admit that it has occurred in the Presbyterian Hospital all too frequently. In the last eight years we have had about fifty-five cases, an incidence of about 1 per cent of our abdominal operations. We are not certain of the exact number because it is probable that this complication has frequently been omitted from the diagnosis file particularly in those cases in which there was no secondary closure. Our actual incidence may be 2 per cent. We have carefully analyzed fifty of these cases without any conscious selection with the idea that they would furnish us with sufficient data to serve as a basis for the discussion of its causes and prevention. In the present symposium we shall treat particularly on the factors of wound healing, suture material and wound infection.

In going over these cases it is apparent that in some the disruption is the *result* of post-operative complications such as vomiting, hiccough and distention and in other cases it is the *cause* of these complications. In some cases it is just one of many bad features of a fatal post-operative course and in others it is the major cause of the fatal outcome.

The faults which lead to wound disruption may be inherent either in the patient or in the technic of operative and post-operative care. When we come to analyze our cases it is evident that the surgeon may well be more responsible than the patient. The factors inherent in the patient are shown in Table I. Certain conditions of the patient, which may have a bearing on wound disruption are unavoidable, such as age and sex. In our series it was much more common in patients over forty, and twice as common in males as in females. We were surprised to find how often these patients were in good condition. Disruption occurred much more often in contaminated and infected cases than in clean cases. There may be an infection in progress when the patient comes for operation, or the operation may require opening or removing a bacteria-containing viscus.

¹ Read before the New York Surgical Society, November 8, 1933

MELENEY AND HOWES

TABLE I
Factors Attributable to Patient

Age		Sex		Condition	
0-20	3	Male	36	Good	21
21-40	11	Female	14	Fair	20
41-60	21			Poor	9
61-80	15				

Bacterial Factor at Time of Operation

Clean	14
Contaminated	28
Infected	8

Disruptive Force

Undue Activity	14
Vomiting	38
Cough	29
Distention	38
Hiccough	18

On the other hand, certain other faults which we ascribe to the patient may be partially controlled or improved by the surgeon. Before operation the patient may be emaciated, dehydrated, anæmic, or in shock, and there may be time for improving his general condition in preparation for the operation. After operation he may be over-active, restless, disoriented, excited, distended. He may vomit, cough or hiccough. The surgeon is partially responsible for the occurrence and continuance of these conditions and may be able to diminish or prevent the operation of these disruptive forces.

Furthermore, the surgeon is responsible, on his own account, for certain conditions which may contribute toward the disruption. These are shown in Table II. He is responsible for his sterile technic, for his trauma of the tissues, for the type of his incision, for his decision with regard to the type and location of drains, for his choice of suture material and for the employment of the various kinds of stitches which may be used to appose the layers of the abdominal wall.

TABLE II
Factors Attributable to Technic

Incision		Drains	
Upper vertical	33	Yes	19
Middle vertical	4	No	31
Lower vertical	4		
Upper oblique	7		
Upper transverse	2		
Suture Material		Retention Sutures	
Continuous plain catgut	4	Circular	2
Plain and chromic	2	Bolt	3
Continuous chromic	42	Lateral	
Interrupted chromic	1	Buttons or rubber tubes	17
Continuous silk	1		

DISRUPTION OF ABDOMINAL WOUNDS

Table III shows the types of operations in which disruption occurred in our series. The frequency of cholecystectomy and gastroenterostomy is remarkable and brings up a number of questions with which we do not have

TABLE III

MAJOR CAUSES OF DISRUPTION		OPERATION	
Cough	14	Cholecystectomy	13
Infection	11	Cholecystostomy	2
Gastric lavage	9	Cholecysto-duodenostomy	1
Distention	7	Gastroenterostomy	10
Hiccough	7	Gastrectomy	1
Vomiting	6	Colocolostomy	1
Undue activity	6	Exploratory	5
Digestive ferments	3	Peritoneal adhesions	3
MINOR CAUSES OF DISRUPTION		APPENDICECTOMY	
Vomiting	28	Acute	3
Distention	20	Chronic	3
Cough	13	Closure perforated ulcer	3
Hiccough	11	Peritoneal abscess	1
Gastric lavage	9	Ventral hernia	2
Infection	7	Spleneectomy	2
Undue activity	4		
OUTCOME		DAY OF DISRUPTION	
Died	22	3rd	3
Survived	28	4th	2
		5th	3
		6th	4
		7th	8
		8th	5
		9th	12
		10th	7
		11th	4
		13th	1
		15th	1

time to deal. The table also indicates the major and minor factors apparently responsible clinically for these disruptions. Beside the disruptive forces mentioned above it will be seen that infection and gastric lavage were important factors. The mortality is very high, 44 per cent. These features may be discussed by the others in greater detail. Of particular interest to us is the portion of the table showing that the greatest number of disruptions occurred from the seventh to the tenth day. This is shown graphically in Fig. 1 and the curve is correlated with the curves of catgut absorption and wound healing. The importance of this will be brought out below.

Discussion—We have briefly indicated how the surgeon may minimize certain factors attributable to the patient, particularly with regard to improving his general condition and avoiding the disruptive forces. How may the surgeon analyze his own technic with a view toward minimizing the

MELENEY AND HOWES

faults inherent therein? Let us assume that the sterile technic is unapproachable and that there is a minimum of trauma to the tissues from cutting instruments, artery clamps and retractors. We cannot ascertain any of these things from the records. The surgeon comes to the closure of the abdominal wall. He selects a suture which has a certain tensile strength and approximates tissues which have a certain holding strength for the suture. The suture exerts a pressure upon the tissue and the ability of the tissue to resist this pressure determines whether death of the contiguous cells does or does

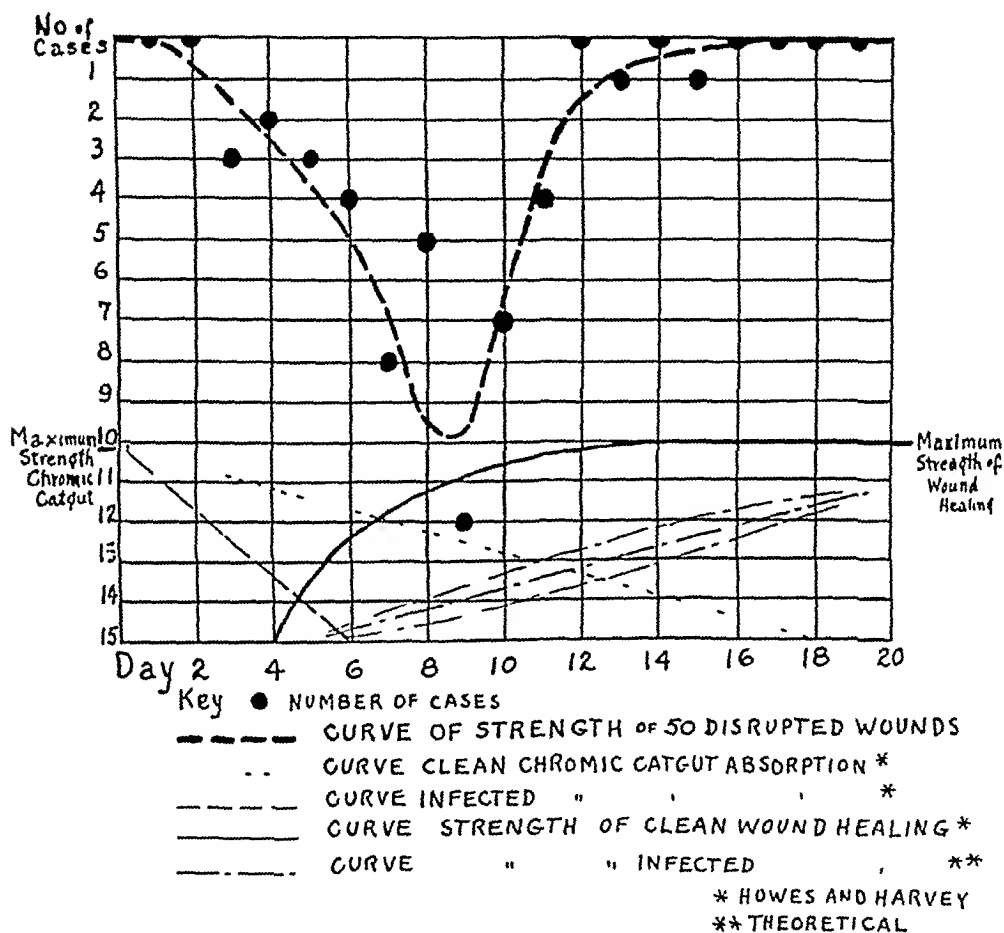


FIG. 1.—Curve indicating the post operative strength of abdominal wounds which disrupted as indicated by the number of disrupted wounds occurring on indicated post operated days correlated with curves for chromic catgut absorption and wound healing

not ensue. Along the course of the sutures some cells are killed by the needle and others are later killed by the pressure of the suture. When the wound is finally closed an equilibrium is reached between the force of approximation of the suture and the force of retraction of the tissues. The tension on both tissue and suture is being altered constantly by breathing, coughing, moving, vomiting, hiccoughing or distention. At any time, if the force is great enough, the suture material may either break or cut through the tissue. It has been shown that in the process of wound healing there is at first a period of exudation of fluid and wandering cells into the region of the wound.² The dead and injured cells, the extravasated blood and

DISRUPTION OF ABDOMINAL WOUNDS

lymph, the foreign bodies such as dust and bacteria which have fallen into the wound or have been carried in from the deep skin glands, and the suture and ligature material which has been voluntarily placed there, excite this exudation. The tissues become swollen and soft, the tension produced by the stitches is increased and the sutures cut deeper into the tissues. If the suture material is absorbable it becomes progressively weaker. Howes and Harvey³ have shown that chromic catgut will resist absorption under the serosa of the dog's stomach for sixteen to twenty days if it is not infected but if bacteria are active in the wound chromic catgut is absorbed with great rapidity. Furthermore even sterile exudate favors catgut absorption. Roughly speaking the greater the amount of exudate the more rapid is the absorption. We must assume that every operative wound is contaminated by an or skin organisms. Their number and their ability to proliferate have a direct bearing upon the amount of exudate produced in the healing wound and the rapidity of healing is affected thereby. When a disruption occurs, careful bacterial cultures should be taken even in those cases which grossly show no evidence of infection for bacteria may play a greater role than one suspects even in apparently clean cases. If the stomach or intestines have been opened, proteolytic ferments may act upon the catgut and the fibrin and thus diminish the holding power of the tissues or delay the process of repair. In any event the tensile strength of sutures and the holding power of the tissues diminish progressively and rapidly during the first week after operation. The reparative process, on the other hand does not start immediately. There is a period of lag, of long or short duration, depending upon the condition of the patient, and the individual tissues concerned and the degree of infection present. Under ideal conditions, after forty-eight hours, fibroblasts begin to appear and lay down then fibrils or utilize the fibrin in the reconstruction of the bridges which will eventually make up the scar binding together the wound surfaces. In clean cases, when healing starts it does so with great initial velocity which gradually slows down at the end of a week or ten days. Now if the weakening of the holding power of the sutures and the tissues progresses more rapidly than normal, or if the reparative process is unduly delayed or if the wound is subjected to a force greater than these two elements of wound approximation can bear, disruption will occur.

The whole problem resolves itself down to these three questions. How can the period of suture or tissue holding be prolonged? How can the reparative process be hastened? And how can an increase of disruptive force be prevented?

We think that it has been demonstrated beyond a doubt that silk is better suture material than catgut for clean cases^{4, 5, 6}. There is less exudation in wounds in which it is used, there is less likelihood of infection and there is little or no diminution in its tensile strength. We are ready to advocate that it be used in all clean cases. It should not be used, however, in infected cases or in cases which are contaminated by the entrance into or removal of a contaminated viscus, except perhaps in an operation in which this contami-

nation is under complete control and there is little or no possibility of contaminating the wound, as, for example, in the removal of an uninflamed appendix or in a hysterectomy. For frankly infected and contaminated cases, catgut must be used.

Now, what of the absorbability of catgut? Plain catgut is absorbed completely in a few days.³ By chromicizing absorption is delayed. Some catgut firms claim that chromic sutures will hold the sutured tissues for ten, twenty or forty days, others that they will resist complete absorption for that length of time. These claims are based on animal experiments which do not and cannot duplicate actual operative conditions in man. Certainly the question of absorbability of catgut is of great importance and yet the Committee on Catgut Standards of the American Medical Association has not been able to persuade the catgut firms to agree upon any standard of catgut absorbability to which they can or will make their product conform. And, as far as we know, there is no test which can demonstrate whether a given brand of catgut will or will not resist absorption a sufficient length of time for it to be reliable for all the requirements of suture material. In practically every case of disrupted wound in our series no matter whether it occurred on the third or thirteenth day the operator reported the complete digestion of chromic catgut, used for suturing the tissues. This was true even in cases in which there was no evidence of wound infection and from which bacterial cultures were negative. At the present time, therefore, we have no real evidence that chromic catgut will hold the tissues for twenty days or even resist complete absorption for that length of time.

Retention sutures offer another problem. For a long time circular stitches of silkworm gut were used regularly in the Presbyterian Hospital, but these frequently cut into the tissues and favored the development of stitch abscesses. At the same time disruption frequently occurred in wounds in which they were employed. Because of the dissatisfaction with these sutures in recent years silkworm gut or silk has been tied to pearl buttons or rubber tubes, on either side of the wound, or "bolt" sutures of the same materials have been passed from the lateral side of the wound over to the linea alba and back and tied to a button or tube. The fault with all types of retention sutures seems to be that they may not hold the peritoneum. The only restraint which they have upon this layer is that which is transmitted through the tissues which bind this layer to the layers through which the retention sutures pass. It is probably the peritoneum which ruptures first in disrupted wounds. Freeman's idea of the omental wedge⁷ seems reasonable and care in suturing must be concentrated upon the peritoneum and posterior sheath. If the circular retention stitches do not pass through the peritoneum and posterior sheath they exert very little restraint against increased pressure from within the abdomen. If they pass through the peritoneum, there is some restraint, but it is minimal at that point because it is on the circumference of the circle where pressure necrosis produced by the stitch is greatest. Retention sutures tied to tubes or buttons also have their defects. If there is any curve in

these sutures it is obvious that they will exert a cutting pressure on the tissues in the plane of the circle of which the curve is an arc. Any pressure from within the abdomen tends to flatten this curve, widen the end points, and lessen the restraint exerted on the line of peritoneal closure. Only if these retention sutures or bolt sutures lie in a perfectly straight line from one end point to the other will they exert any real restraint on the peritoneal line of closure. How often do you suppose these retention sutures take such a direct course? It would seem, therefore, with all of the faults to be found with retention sutures that the solution of the problem lies in the attention paid to the actual direct suturing of the peritoneum and posterior sheath. It seems to us that the best approximation of the peritoneum and posterior sheath is accomplished by the "mattress" type of suture either as a continuous or interrupted stitch and reinforced by an interrupted or continuous over-and-over stitch of fine chromic. Either the continuous or the interrupted alone has its faults. Our series would seem to indicate that the continuous suture is particularly bad. The tensile strength of O chromic catgut is greater than the holding power of any tissue likely to be sutured with it.⁵ Larger sizes, therefore, need not be used, for they undoubtedly increase the post-operative exudation. When they are used the tendency is to tie the sutures too tightly, or pull up on them too strongly, resulting in great tissue necrosis.

The adequate closure of the peritoneum also brings up the question of drains and the types of abdominal incisions. If drains pass into the peritoneal cavity, the peritoneum should not be sutured too tightly about them. On the other hand, if it is closed too loosely about them, the omental wedge may work its way in. Although our figures show a higher number of undrained than drained cases it must be remembered that the total number of drained abdominal wounds is very much lower than the number which are not drained. It seems almost self-evident, therefore, that disruptions will occur in a higher percentage of drained than undrained cases. Probably drains are too often used, even in cases of peritonitis. In many cases of established infection in the peritoneal cavity drains do very little good. In such cases closure of the peritoneal cavity with drainage down to but not through the line of peritoneal closure is good surgical practice. In most cases in which drainage of the peritoneal cavity is necessary or advisable care must be taken to close the peritoneum about the drains in such a way as to prevent the protrusion of omentum or other viscera.

Now, with regard to the type of incision, our review shows that disruption is very much more common in the vertical than in the horizontal incisions. The oblique incisions take an intermediate position. We do not have the figures at present with regard to the total number of vertical, oblique and transverse incisions, and, therefore, cannot state definitely what percentages would show, but we believe that there are at least two good reasons why vertical incisions are more apt to disrupt than transverse

wounds. In the first place, the fibres of the posterior rectus sheath run transversely. Every one knows how often the needle or the stitch splits the sheath when an attempt is made to suture a rectus or paramedian wound, anywhere from the ensiform down to the semilunar fold of Douglas. A mattress suture is less likely to split the sheath than an over-and-over stitch, but even with the mattress stitch the splitting may be most annoying. This almost never occurs with the suture of a transverse wound and one is therefore never bothered with protrusion of omentum through a split stitch hole. Likewise the elastic fibres of the skin run transversely for the most part. It often requires considerable pull on the skin sutures to approximate a vertical incision, while a transverse skin wound frequently approximates itself, or can generally be brought together with very little tension. The linear scar of a transverse wound as compared with the broad scar of a vertical wound bears testimony to this fact. In the second place the position that the patient assumes or may assume after operation favors the closure of a transverse wound and favors the opening of a vertical wound. Suturing a transverse wound may be facilitated by breaking the operating table so as to raise the shoulders and thighs. After his return to bed the patient may be raised slightly on a Gatch spring and relieve all tension on the wound surfaces of a transverse incision. In like manner the lateral pull of all abdominal muscles except the rectus abdominis favors separation of vertical wounds while this pull has a tendency to close transverse wounds. To be sure, if the rectus muscle is cut across by a transverse incision contraction tends to separate it, but this may be largely prevented by mattress sutures passing through muscle and anterior sheath while passive flexion of the back by raising the Gatch bed relaxes the rectus muscle. The scar which results in the muscle is not unlike an anatomical transverse tendinous intersection.

To sum up, disruption of abdominal wounds with protrusion of viscera is an accident which may be minimized or prevented by the recognition of the predisposing and direct causes and the persistent effort to minimize or prevent their operation. This includes the ante-operative preparation of the patient so as to improve his general condition, and the post-operative prevention or suppression of restlessness, undue activity, vomiting, cough, hic-cough and distention, and the avoidance of gastric lavage, particularly from the third to the twelfth day. If lavage is necessary, a small nasal duodenal tube should be used. In cases in which the gastro-intestinal tract has been opened consideration should also be given to the neutralization or absorption of the digestive ferments. The efforts to prevent disruption also include the greater use of fine silk in clean cases and the use of catgut of assured dependability from the point of view both of sterility and absorbability in contaminated or infected cases. It includes the sure approximation of the peritoneum and posterior sheath by careful closure with fine sutures (reinforced, if necessary) and the intelligent use of drains and retention sutures. Finally, it includes the greater utilization of transverse incisions.

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DISRUPTION OF ABDOMINAL WOUNDS *

BY RALPH COLP, M.D.,
OF NEW YORK, N.Y.

FROM THE MOUNT SINAI HOSPITAL

SOKOLOV,¹ of Leningrad, U.S.S.R., in 1932, collected and completely reviewed 730 cases of wound rupture after laparotomy with exposure and prolapse of the abdominal contents. His paper, which is thoroughly analytical in all its details, should act as a model for future studies, and should stimulate other surgeons and clinics to report their experiences with this unfortunate post-operative complication.

There are several phases to this problem which are quite obscure and many questions which still remain to be solved. Is wound rupture due to a failure of operative technic, are there certain types of cases more prone to it than others, can its occurrence be forestalled and adequately protected against, or is it, in its final analysis, an unavoidable complication?

This review is based on twenty-six cases of wound rupture with exposure or prolapse of the abdominal contents gathered from a careful study of 2,750 consecutive laparotomies from the surgical and gynecological ward services of the Mount Sinai Hospital of New York City. In addition, three cases are added from the private service, making a total of twenty-nine cases which are analysed in the course of this paper.

Sex and Age—Wound disruption occurred in fourteen of 1,249 male patients (1.12 per cent), and in twelve of a total of 1,501 female patients (.75 per cent). Sokolov reported that it occurred twice as frequently in men as it did in women, in this series the ratio was 7:5. It is probably true that women stand operations better due to a certain biological superiority. The physical influences of hard manual work, the excessive use of nicotine and alcohol are bound to have their deleterious effects upon the general physical economy of men, making them poorer surgical risks. The greater elasticity of the abdominal wall, together with the thoracic character of breathing in the female when compared to the muscular development of the male abdomen with its abdominal type of respiration, probably make wound separation less likely in women.

A study of Table I shows that no period of life is exempt, and that it occurs from childhood to old age. The greatest incidence appears from the third to the fourth decade, but this is to be expected since it is during this twenty-year period that most surgical operations are performed.

Season of the Year—Sokolov was inclined to believe that the season of the year exerted a direct influence upon the incidence of wound dehiscence. His statistics proved that most wound separations occurred during the winter.

* Read before the New York Surgical Society, November 8, 1933.

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TABLE I

Age Incidence and Wound Dehiscence

Age	No	Age	No
1-9	2	40-49	8
10-19	0	50-59	4
20-29	3	60-69	1
30-39	9	70-79	2

and spring months. He felt that in the northern countries, especially Russia, more time was spent indoors during this period and that the food which was eaten was sadly deficient in fresh vegetables. The result was a loss or absence of certain essential vitamins with a devitalization and general atony of the tissues, a condition not unlike that observed in scurvy. However, there was no seasonal relationship in the frequency of abdominal disruptions in this series.

The primary disease undoubtedly is the most important factor underlying the etiology of wound rupture. While it is true that rupture of the abdominal wall may occur in any disease affecting the peritoneum or its contents, it appears to be associated more frequently with some diseases than with others. It would seem logical to suppose that illnesses of a protracted nature attended by emaciation, anaemia, cachexia and weakness, and those of acute and chronic intoxications associated with long bouts of temperature, might devitalize the individual sufficiently to interfere with the reparative powers of the tissues and wound healing. A study of Table II substantiates this contention. Malignant tumors with their undeniable debilitating effect upon the body are responsible for most wound disruptions. There were 316 cases of carcinoma affecting various organs, and in these patients, the percentage of dehiscence was 2.2 per cent. Certain benign growths like uterine fibroids are often attended with harmful systemic effects, particularly secondary anaemia, definitely impairing proper metabolism. In a total of 842 gynecological operations, wound disruption occurred in 6 per cent of the cases, yet the incidence in fibroid disease was 2.2 per cent. Gall-bladder disease so frequently associated with liver and kidney damage cannot fail but leave an indelible imprint upon the reparative powers of the tissues, and in 401 cases, the percentage of separation of the abdominal wall was 1.5 per cent. In addition, wound disruption was met with in such conditions as acute appendicitis, 5.4 per cent, general peritonitis, diverticulitis of the sigmoid, etc. It occurred in ten acute diseases, and in nineteen of the chronic variety. Yet in the vast majority of patients, in spite of the underlying disease, even in carcinomas, fibroids and chronic inflammations of the bile ducts, over 97 per cent have the tendency to heal, and it is impossible at present to foretell which cases will dehiscence. There are general prophylactic pre-operative measures which might prove generally useful in promoting a smoother convalescence, and thereby better healing. Obese individuals should be scientifically reduced, diabetic and nephritic tendencies should be properly controlled medically and dietically, ill-nutritioned, debilitated and anaemic patients should

be properly fortified by the administration of a proper water balance, by transfusions, by a high caloric diet rich in vitamins, and by sunlight treatment, if necessary. The observance of these principles in specific cases not only probably contributes to stimulate the healing processes and diminish the incidence of dehiscence, but will greatly reduce the morbidity and mortality of surgery in general.

TABLE II

	Per Cent
Malignant tumors	28
Inflammatory diseases of the bile passages	23
Gynecological diseases as fibroids	19
Acute appendicitis	19
Other conditions as diverticulitis of the sigmoid, streptococcus peritonitis, fever of undetermined origin, etc	11

Anæsthesia—It is quite evident that this plays an insignificant and unimportant part. It has been fairly well established that disruption occurs after local, spinal and inhalation anæsthesia, and specific reports as well as a study of these abstracted cases seem to bear this out.

Type of Incision—Modifications of the standard abdominal incisions are constantly being reported. It is continually hoped that certain improvements in approach will not only provide the maximum of adequate exposure with the minimal amount of nerve injury, but that the incision itself may be safely and securely sutured without the risk of subsequent wound rupture. Statistics on the incidence of wound dehiscence following abdominal incisions are misleading. These depend mainly upon the frequency with which particular incisions are used in a surgical clinic and the type of disease treated. In a series of 606 cases of abdominal-wall ruptures collected by Sokolov, the mid-line incisions constituted 76.4 per cent of the total number. But it must be remembered that the majority of these were gathered from European clinics in which the mid-line incision has been the method of choice for coeliotomy for many years.

It would seem at first glance that any incision through the linea alba would be especially prone to disruption. This fibrous band is notoriously poor in its blood supply, and because of its formation any forced, sudden or unusual contraction of the transverse and oblique muscles of the abdomen would tend to pull it apart, especially if the intra-abdominal pressure were increased by cough, hiccough, vomiting or meteorism.

Sokolov's figures of median line wound dehiscence indicate that 229 cases occurred above the umbilicus (57 per cent), and 167 below the umbilicus (42.18 per cent). In other words, rupture above the umbilicus occurred 25.64 per cent more frequently. On the other hand, Madelung,² in an analysis of his material based on mid-line incisions, reported 124 cases below the umbilicus, and sixteen above. It should be remembered, however, that the statistics of Madelung included many gynecological conditions which are especially prone to dehiscence. These comparative figures are not given to

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cloud the issue but to emphasize again that isolated percentages as such mean nothing. A careful analysis must always be made of the sources from which the statistics are derived.

Mid-line incisions in this series were made in only 236 patients, less than 9 per cent of all cases. A median epigastric incision, however, was used in 27 per cent of the procedures involving the surgery of the upper abdomen. It was used mainly in radical resections for duodenal and gastric ulcer, and gastric carcinoma, and in 231 cases of this nature not a single instance of wound dehiscence was recorded.

It has been learned by past experiences in this clinic that the median epigastric incisions were prone to separate. In order to combat this, a special technic of wound closure was evolved, and since its adaption, this untoward complication has been effectively eradicated. Seventy per cent of these median incisions made for gastroduodenal ulcer, and practically all dealing with carcinoma of the stomach were sutured by a single layer of interrupted through-and-through sutures of heavy braided silk which were not removed until the fourteenth day. But this shall be discussed in greater detail in the paragraphs devoted to the technic of wound closure.

The most popular incisions in this clinic have been those which have been parallel to the linea alba through the rectus muscle. The favorite approach to the upper abdomen has been the vertical splitting of the upper part of the rectus muscle. It was used in 73 per cent of the cases dealing with disease in the upper quadrants.

Whether incising the overlying fascia, that is the anterior rectus sheath, obliquely or in the same direction as the fibres of the rectus, appears of little moment and modifications as the Bevan incision, or the hockey-stick variety have been too few to draw any definite conclusions. Wound rupture occurred in 22 per cent of this type of incision. This is an appreciable incidence and demands analysis. It would be fair to predicate that wounds in the upper portion of the abdomen are more prone to separate than those in the lower. Moschicowitz³ states that in the upper rectus vertical incisions, especially in the obese or very muscular, "the suture line is weak, and there are generally present also a number of smaller or larger holes which permit the prolapse of omentum. It is of interest to know that Sprengel found at autopsy a few cases which died shortly after laparotomy through a vertical incision that the peritoneal suture line had completely separated." Undoubtedly this contributes to the greater incidence of wound dehiscences in the upper rectus incisions. Besides cough, hiccough, gastric dilatation and vomiting appear to exert greater intra-abdominal pressure in this area. A survey of the lower rectus muscle-splitting incisions as a group showed the incidence of wound separation to be 54 per cent. This would seem to substantiate this aforementioned predication were it not for the fact that in the paramedian hypogastric incision, a specialized type of lower rectus muscle-splitting incision, the incidence was 15 per cent.

Is, then, the type of incision the responsible factor in the etiology of the disruption, or is the underlying disease the major element in its production?

An analysis of ten cases, Nos II, IV, VII, XI, XV, XVI, XVII, XXV, XXVII and XXIX, in which the upper rectus muscle-splitting incision was employed, calls attention to several salient and important features in answer to this question.

While pulmonary complications were present in five, and abdominal distention in three as the exciting causes, a carcinoma was present in three, chronic gall-bladder disease in six, and a prolonged period of temperature with marked anæmia in another. In other words, while the mechanical factor played an important role in almost all, the underlying disease with its tendency to poor and ineffectual healing constituted the basic element in the etiology of abdominal disruption. Similarly, the rather high incidence of rupture, 15 per cent in 518 cases of paramedian hypogastric incisions was fundamentally dependent upon the effects of the underlying disease rather than the incision *per se*. An analysis of the eight cases of paramedian wound dehiscence, Nos X, XII, XIII, XIV, XX, XXII, XXIV and XXVI, showed them all to be in women. The precipitating factors were pulmonary complications in three, marked emesis in four, and no assignable cause in one. The pathology at operation disclosed uterine fibroids in five, a high retroperitoneal cyst in another, a carcinoma of the ovary in the seventh, and finally a diverticulitis of the sigmoid in the eighth. A certain number of large uterine fibroids, enormous retroperitoneal cysts and carcinomatas, are often associated with an anæmia and generalized debility. These factors, together with the length of the abdominal incision which is used in most of these cases, must undoubtedly exert a depressing influence in the rate and quality of wound healing, with a resultant high incidence of wound disruption. Yet, on the other hand, it is of more than passing interest to note that this same type of incision was used in forty-six cases of ectopic gestation, ninety-three instances of benign ovarian cysts, and more than sixty other cases of acute and chronic diseases of the pelvic generative organs. There was not a single instance of wound dehiscence in these 199 cases, probably showing that the systemic effect of these specific pathological conditions does not materially influence the soundness of wound healing.

The sites of the lower rectus muscle-splitting and Kammerer incisions are practically adjacent to the paramedian area, and the anatomical structures involved are practically the same. Yet the incidence of wound rupture in the lower rectus group was 54 per cent in the muscle-splitting incisions, and 45 per cent in the Kammerer variety. The most frequent disease approached through these incisions was either the acute or chronic inflammation of the appendix.

The lower right rectus muscle-splitting incision was used in 768 cases. Dehiscence occurred in four cases, Nos III, V, VI and VIII. All were cases of acute appendicitis which were drained. The skin was left open and packed in two, one disrupted on the second day with no assignable precipitat-

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ing factor, and one on the fourth following a cough incident to bronchopneumonia. The third patient developed a paralytic ileus with terrific meteorism and in the fourth there was an unsuspected carcinoma with a bronchopneumonia.

The Kammerer incision was employed in 439 cases. This incision is an excellent approach to the lower abdomen. After incising the rectus fascia, the muscle is pulled to one side so that no tissue is destroyed, and the nerve supply is fairly well preserved. Wound rupture occurred in two, Cases IX and XXII. One was a twenty-two-month-old infant (Case IX), with an acute appendicitis with abscess, and the other was a child with a generalized streptococcaemia with a diffuse peritonitis (Case XXII).

The McBurney incision should prove an ideal protection anatomically against evisceration. It is used but occasionally in this clinic because of certain limitations of exposure and has been almost entirely supplanted by the right rectus group of incisions. It was used in only forty-nine patients. There were no wound ruptures, although Sokolov cites two cases in which there was evisceration even after this incision. There were no instances of separation of the abdominal wall in twenty-nine subcostal incisions used mainly for high gastric resections and splenectomy, in twenty rectus overlap for umbilical hernia, and in three upper transverse incisions. The latter incision enjoyed great popularity for a time in this clinic, but with the retirement of its sponsor it gradually was used less and less, and in a period of five years it was employed only on three occasions. The Sprengel incision is an ideal anatomical approach: no nerves are injured and the divided rectus heals with the addition of another linea transversa. The only objection to it is the added time in making and in closing the incision. Men who have used it extensively claim that wound separation is most unusual and that the scars are quite firm.

These numbers of special incisions are comparatively few and it would be unjustified to draw conclusions with this limited material, especially since cases of wound dehiscence following each type have been reported in the literature.

There were twenty patients in which a para-umbilical rectus muscle-splitting incision was made. This incision, useful in cases in which the pre-operative diagnosis is doubtful, usually begins opposite the umbilicus and is prolonged either upward or downward depending upon the pathology found. It divides the same structures practically as either the upper or lower rectus incisions. While nerve division may be related to poor wound healing as certain experimental evidence shows, there is no greater division of nerves in the para-umbilical than in the upper rectus incisions and there is no reason why dehiscence should be greater after this type than the others. Yet in this small series of twenty, there were two in which disruption occurred (Cases VIII and XIX). The former was an acutely inflamed perforated appendix in which the skin was left open and disruption occurred within twenty-four hours, and the other concerned a huge retroperitoneal spindle-

cell sarcoma with metastasis. Wound separation in these two instances may be explained by the extenuating circumstances present rather than the use of the para-umbilical incision.

• Operations performed through previous scars have the reputation of being more likely to separate than those of a primary incision. This was not substantiated in the current series. There was not a single case of wound separation in the ward series of sixty-one patients re-operated through a previous incision. It is a matter of common knowledge that patients as a rule who stand one operation well invariably tolerate secondary procedure well. Besides, the secondary procedures as a rule are not in the groups liable to evisceration. There are, however, a few simple principles which must be borne in mind. The pre-existent scar must be excised widely enough to freshen the edges of the layers of the abdominal wall, and yet not too much tissue must be sacrificed, otherwise unnecessary tension will result upon the sutured abdominal wall. The only occurrence of wound separation in a secondary operation was Case XX, a private patient. He was operated on thirteen years previously for an acute pancreatitis, and at that time a cholecystostomy was done. His second operation, which consisted of a cholecystec-

TABLE III
*Relationship of Type of Incisions to Wound Dehiscence**

Incisions	No	Number and Percentage of Ruptures
Median epigastric	236	0
Left subcostal	28	0
Right subcostal	1	0
Upper transverse	3	0
Upper right rectus muscle-splitting	347	8—2 3 %
Upper oblique rectus muscle-splitting	90	2—2 2 %
Bevan	31	0
Hoekey stick	10	0
Secondary upper right rectus muscle-splitting	26	0
Secondary upper left rectus muscle-splitting	21	0
Right rectus para-umbilical	20	2
Left rectus para-umbilical	1	0
Lower right rectus muscle-splitting	768	4—0 51 %
Right Kammerer	439	2—0 46 %
Paramedian hypogastric	518	8—1 5 %
Secondary lower right rectus muscle-splitting	24	0
lower left rectus muscle-splitting	103	0
Secondary left rectus muscle-splitting	11	0
Right McBurney	49	0
Umbilical hernioplasty	20	0
horizontal overlap—15		
vertical overlap—5		
Stab-wound closure	4	0

* Three private cases are not included in these statistics

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tomy for cholelithiasis and chronic cholecystitis, was performed through the original incision. After a stormy post-operative course characterized by persistent hiccough and vomiting, dehiscence occurred on the seventh day. Wound dehiscence in secondary cases should not be greater under normal circumstances than in primary ones.

Operative Procedure—The magnitude and the time consumption of the operative procedure seem of little moment so far as abdominal disruptions are concerned. It may happen after a simple exploration of ten to twenty minutes' duration or it may occur after a more serious procedure occupying one to two hours. In order to be more specific there were 172 gastrectomies without an evisceration yet in 640 appendicectomies for acute appendicitis, it occurred four times and in 184 explorations, it happened once. In other words the technical procedure as such can usually be discounted as a potent factor in the causation of wound dehiscence. The fundamental cause cannot be found in the character of the procedure but must be assigned rather to the underlying disease for which the surgery was instituted.

The Technic of Wound Closure—Most surgical clinics employ a standardized technic in closing abdominal incisions. Ours is very simple and although it may vary slightly in the hands of a few operators, it is essentially the same on the four surgical and the gynecological services. The peritoneum in any type of incision except the median epigastric, is closed with a continuous chromic catgut suture. The muscle is rarely sutured. The fascia is invariably approximated by interrupted sutures of chromic catgut, care being taken to pass the sutures close to the edges of the divided fascia at regular intervals. This chromic is not tied too tightly for by this simple expedient tissue is not ruthlessly strangulated. The fascia in clean simple cases, such as chronic appendicitis, is often closed by a continuous suture or a continuous suture of chromic interrupted at intervals. The skin is approximated either by a continuous silk, interrupted silk or silkworm, or by pincettes, or by a combination of both. Occasionally the routine closure is supplemented by interrupted retention sutures of silk or silkworm passed through the skin, subcutaneous tissues, the underlying fascia and muscle. Retention sutures, however, are being used infrequently and were added in less than a dozen of 2750 patients. The omission of retention sutures was responsible for the paucity of fat necroses with liquefaction and deep stitch abscesses. It is extremely dubious whether its routine use would cause fewer dehiscences (Cases XVI and XXIX). It would not compensate for the localized necrotized damage it causes in the wounds of most patients.

Whatever may be said pro or con for a 9 per cent incident of wound dehiscence in relationship to the technic of wound closure, it represents the results obtained in an institution in which layer sutures of chromic catgut is the rule. The silk layer technic is never employed in laparotomies.

There has been renewed interest in the Halsted silk technic recently and although the experimental evidence¹ seems to show that "these wounds accumulate strength more rapidly" the same investigator writes that if "cat-

gut were used according to the technic required for silk rather than in the mode in which it is usually employed, catgut would be a more efficient suture material." It must be reiterated that silk has its definite limitations and its strict indications. Its use does not prevent wound separations as the reports of Sokolov attest.

It is undoubtedly true that experimentally the tensile strength of a suture is relatively unimportant in relationship to wound rupture, but clinically this is not always the case. When healing is active, sutures are of mechanical assistance in approximating tissues for a short period only. But should healing be sluggish, interrupted sutures are exceptionally useful in keeping tissues together until the fibroplastic tissues have become sufficiently strong. But the suture material itself must have tensile strength to withstand the strain of possible increased intra-abdominal pressure. It should not disintegrate until the sluggish healing has advanced to such a point as to prevent disruption. There are cases of early dehiscence in which the chronic gut appears to have completely dissolved. Whether this dissolution is dependent upon an idiosyncrasy of the individual to digest catgut quickly, or whether it is due to an inferior grade of catgut, are open questions. While through-and-through sutures of heavy braided silk, which were used in the majority of median epigastric incisions, and especially in all cases of carcinoma do not absolutely guarantee against wound rupture (Case V), they apparently offer greater protection than the routine layer chromic-catgut type of closure, especially if the silk is not removed until the fourteenth day.

These single silk sutures, if not properly introduced, are apt to cut through the tissues. However, there is little likelihood of this accident if the silk sutures are correctly passed near the mid-line, if not too much tissue is included "in the bite," and if the sutures are not tied too tightly.

There are other objections to this crude technic of wound closure. While these wounds as a rule heal fairly well, it cannot be denied that the architectonic strength of the resulting scar has been definitely impaired. The scar has a tendency to widen and become thinner as time goes on, and the eventual incidence of post-operative hernia in my own series is appreciable.

The Day of Rupture—Just when an abdominal disruption occurs is a speculation. It happened from the second to the eleventh day in this series. The seventh day seemed to be the most common and appeared to follow in the wake of the removal of the skin sutures.² The fact is that neither the removal of the skin clips on the fifth day, nor the sutures on the seventh, had little, if anything, to do with the separation of the underlying structures as 99 per cent of all cases prove. The appearance of the gaping abdominal wall with its fibrin deposits, the state of the granulations of the fascia and the muscle, and the type of exudate present on the peritoneum and the exposed abdominal contents, support the view that the disruption of the deeper structures must have occurred at a period much earlier than the surface wound in clean cases would indicate.

It might be advisable to leave the skin sutures undisturbed for longer periods of time in those cases characterized by cachexia, weakness and anæmia, and those complicated by distention and meteorism. This would diminish the small incidence of skin separations, but it would be extremely doubtful if it would exert sufficient influence in keeping the underlying structures intact in cases of poor healing. There were twelve cases in which the skin and subcutaneous tissues separated while the underlying structures remained healed, and several cases in which the skin healed, although the deeper tissues had dehiscenced. It is more than likely that unrecognized cases of this variety may often account for the unexplainable hernias seen at subsequent follow-up examinations.

There were thirty drained cases in which it was deemed inadvisable to close the skin because of the infection present. The superficial wound was, therefore, packed lightly with gauze. Three of this group eviscerated at a very early date. This high percentage is not a mere coincidence. The skin and the subcutaneous tissues aid in the healing processes of the less vascularized fascia, and if this additional source of blood and lymph is denied, the likelihood of fascial separation under adverse conditions is increased. If the infection warrants, it might be better to pack open the entire wound rather than the skin alone. This packing is left undisturbed for ten to twelve days. When it is removed, the granulations are so healthy in appearance that the wound edges may be approximated by adhesive. Healing invariably follows. This procedure was used in twenty-three cases without an untoward result.

Abdominal binders and adhesive strappings have been hailed as valuable aids in preventing wound separation. Unfortunately, what is gained by added support is often lost in the fixation of the upper abdominal muscles and the lower ribs. This plays no small part in limiting diaphragmatic movement with its incident effect on pulmonary atelectasis. The binder, aside from the counter pressure it gives, may prove invaluable as an additional barrier to the escape of the abdominal contents in cases of frank evisceration.

Contributing Factors—Certain complications may arise during the period of healing which, by interfering with the splinting of the abdominal wall, directly contribute to wound separation. The serious rôle which pulmonary complications play in abdominal surgery is well known and the part which they might play as the precipitating factors in wound dehiscence is obvious. Respiratory infections were the responsible agents in at least eleven of the twenty-nine cases. They were manifest clinically by a marked productive cough in five and additional signs of a frank pneumonia in six. Naturally, cough by a forcible contraction of the muscles increases the abdominal movements. One prerequisite for firm union is thereby disturbed, and partial or complete wound rupture may result. But cough alone would not be sufficient unless there was a definite defect in wound healing, for although there were 106 pulmonary complications, dehiscence occurred in only six (5.6 per cent).

Not could excessive vomiting, gastric dilatation or marked distention as such definitely precipitate dehiscence unless other concomitant factors are present. The reasons that these complications in themselves are not more significant are evident. They are not unduly severe in most cases and either invariably subside sufficiently, or disappear completely by the time the crucial period for wound rupture arrives. Emesis and meteorism were noted in eleven of the cases, but in seven it was the manifestation of a paralytic ileus secondary to an acute diffuse purulent peritonitis. Hiccough was a contributing agent in one case, absence of healing in another, and the cause was unknown in two patients. The successful treatment of all these annoying post-operative complications must often aid prophylactically in preventing abdominal rupture in many susceptible patients.

Infections—The relation of infection to the problem of dehiscence is still doubtful although many believe it is of major significance. Wound rupture occurred in fifteen non-drained clean cases without infection. The wound was resutured as soon as evisceration was discovered in ten of these patients, and eight eventually healed without apparent infection. The word "eventually" is used advisedly because forty-six days were required before union was complete. The poor reparative power of the tissues which was fundamental in the causation of the original wound separation was still present. There were over 300 varied wound complications of different degrees of severity without disruption. The more important were 147 purulent infections, fifty-eight fascial necroses, and forty-one hematomata and excessive serum. Yet in this group of twenty-nine wound separations, there was not a single instance in which the infection could be blamed solely for the dehiscence.

Drainage and Wound Dehiscence—Eleven hundred forty-seven cases were drained and 1,603 were not. Thirteen wounds separated in the drained class (1.22 per cent), and in the non-drained group thirteen disrupted (8.4 per cent). The incidence in the drained series was only slightly higher. One would think that the drainage material would act as an irritating foreign body, and as such would favor intra-abdominal adhesions. If wound disruption would occur, the actual evisceration of the abdominal organs would be less than when non-drained wounds ruptured. These are not the facts, however. There was an actual prolapse of omentum, intestine, or both in more than half of the ruptured drained wounds, while only a third of those cases closed without drainage, actually eviscerated. Evisceration in comparison to simple exposure of the contents did not seem to influence the ultimate prognosis. Although there were five frank eviscerations in the non-drained cases, there was no mortality. In the seven drained cases of evisceration, one died.

Diagnosis—This rarely offers difficulties. A dressing previously dry which suddenly becomes stained or saturated with a bloody serous discharge should make one exceedingly suspicious of dehiscence even if inspection shows the skin apparently healed. If palpation, however, gives the impression

that the underlying tissues have separated, the removal of one or two skin sutures will readily confirm a suspicion. Occasionally a case of dehiscence may present the early symptoms of an acute intestinal obstruction due to a subcutaneous kinking of a prolapsed knuckle of gut. Quite often, too, intelligent patients make their own diagnosis by being conscious of a sudden "giving away" of the operative wound following some excessive strain.

Treatment—There are several methods of treatment available for wound disruption. These are secondary sutures over a gauze drain, suture of the peritoneum, muscle, and aponeurosis, suture of the peritoneum with packing of the remainder of the wound, and simple packing without any suture. The tampon method, or the secondary suture of all layers with drainage, are the elective procedures in this clinic. The tampon treatment is the simplest, easiest and least shocking. It is the method of choice in infected cases, and in those desperately ill in which disruption has occurred secondary to a generalized peritonitis. It consists of gently replacing the contents within the abdomen and packing the gaping wound snugly with plain or iodoform gauze. The wound edges are approximated with flamed adhesive. This can be done with the patient in his bed and without anaesthesia. The packing is gradually removed as healing proceeds. Healing requires about thirty-seven days as a rule, and usually upon discharge the wounds are still granulating.

This procedure was used in nineteen patients. The mortality was 32 per cent. Eleven of this group were followed and seven subsequently developed hernia. This is a serious objection to the tampon method since the operative risk of a secondary hernioplasty is not negligible. There were no other complications, although intestinal obstruction due to adhesions and intestinal fistulae due to pressure and damage of adherent gauze are always possible. Innumerable cases of these disagreeable complications have been reported in the literature.

Secondary suture of disrupted wounds is more complicated. It requires transport to an operating room, the administration of a general anaesthetic, and the procedure is productive of considerable shock. It is indicated in clean cases with evisceration and without peritonitis. There were ten cases treated by this method. Eight recovered and two died—a mortality of 20 per cent.

All these cases were removed to the operating room, and there, usually under a general anaesthesia, the prolapsed intestines and omentum were thoroughly washed by irrigation and gently replaced. Secondary suture was performed with interrupted through-and-through heavy silk over drainage in the majority, although Case XII was closed with interrupted through-and-through chromic, approximating the skin edges with retention silkworm sutures, passing through the subcutaneous tissues and fascia. The patient succumbed a month later from the effects of a general peritonitis, the abdominal wall had firmly healed.

There were no untoward complications in the eight cases which recovered and no instance of serious infection resulting from the secondary suturing.

This menace has prejudiced many against its use. The cases were hospitalized on the average of forty-six days, slightly longer than those in which the wounds were packed. Unfortunately, only three of these patients could be followed, two were well and firmly healed, but Case VII showed evidence of a hernia.

It would seem offhand that very little was to be gained by the radical operative procedure, especially since the lower mortality is due to a more careful selection of the less sick cases. But it is extremely hazardous to draw conclusions either from a small series of cases or from a still smaller number of individual experiences. A careful study and critical review of the hundreds of cases collected by Sokolov will convince even the skeptical that the suture method, wherever feasible, is fraught with less post-operative dangers and fewer subsequent serious complications.

Causes of Death—The causes of death as determined by five post-mortem examinations were a diffuse peritonitis in four, and hæmorrhage from the gall-bladder bed with acute dilatation of the stomach in the fifth. Death was attributed to cholæmia in one and peritonitis in two of three cases not proven by autopsy. Wound rupture as such probably contributed very little directly to a lethal outcome. Dehiscence itself is fairly innocuous, but it tokens the presence of fundamental defects and represents the result of serious complications. The mortality in this series was slightly less than 28 per cent. This is greater than the mortality of 22 per cent published by Madelung in 1905, and slightly less than the mortality of 33 per cent of Sokolov published in 1932. Since 1905, surgical indications have extended tremendously and as the procedures have become radical, complications have become more frequent. Just what the post-war period and current economic depression with its incidental mental, nervous and physical strain upon the human organism have contributed are factors which cannot be measured.

SUMMARY AND CONCLUSIONS—Wound dehiscence occurred in 9 per cent in a series of 2,750 consecutive laparotomy cases. It seemed to affect men slightly more than women, and no age seemed immune to its occurrence. The anaesthesia, type of incision, magnitude of the operation, and method and technic of wound closure, drainage or wound infection, bear little or no relationship to its frequency. While no disease affecting the peritoneum or its contents is free of this complication, it appeared to be more frequent in certain diseases, especially in carcinoma, certain gynecological conditions, notably uterine fibroids and chronic infections of the biliary system, in fact those maladies characterized by chronic toxæmia and accompanied by anæmia, cachexia, weakness and general debility. The crux of the problem seemed to rest in the failure of regenerative powers of the tissues to promote firm healing. It was aided and abetted by certain precipitating factors as pulmonary infections, gastric dilatation and meteorism. The diagnosis is simple. The treatment seems to be divided between tamponade and secondary suture. The mortality is 28 per cent. It appears dependent upon the fundamental disease with its complications rather than the wound dehiscence. Consider-

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able can be done prophylactically in the proper pre-operative preparation of patients and in the immediate post-operative treatment of pulmonary and abdominal complications in the prevention of wound dehiscence. Wound dehiscence will never be an unavoidable surgical complication until methods are available to accurately differentiate those patients with poor reparative powers, and until means are at hand which will unfailingly promote the prompt healing of tissues in these specific cases.

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DISRUPTION OF ABDOMINAL WOUNDS¹

By RODERICK V. GRACE, M.D.

OF NEW YORK, N. Y.

FROM THE FIRST SURGICAL DIVISION OF BELLEVUE HOSPITAL

It is the experience of nearly every general surgical service to be confronted, and often unexpectedly, with that distressing and serious complication of abdominal incision known as disruption of the operative wound. Although this complication is more frequent than is generally known, the literature for the most part is sparse and the causes and prevention of this post-operative accident are far from settled. On this account the author wishes to present an analysis of a group of cases illustrating the condition, taken from the records of the First Surgical Division, Bellevue Hospital. The period covered by these records is approximately fifteen years. Owing to the work involved it is not possible to state the total number of abdominal operations carried out on this service in the period studied, and therefore the relative frequency of this post-operative complication cannot be stated.

The total number of cases of abdominal wound disruption was forty-six in all. These cases were divided into two groups, *viz.* (A) Abdominal wound disruption with protrusion of viscera, thirty-six cases, (B) abdominal wound disruption without protrusion of viscera, ten cases.

This accident to wound healing was general in that every surgeon on the division doing abdominal surgery had experienced one or more operations with this complication.

As children are not cared for on our service, the age limits in our series were found to be from thirteen to seventy-one years. Age did not seem to influence the occurrence of wound disruption except that in a large group of cases the probabilities are that the larger percentage of cases will occur in the decades of life in which abdominal carcinoma is more frequent and subject to surgical exploration. The sex of the patients seemed to bear no relation to this condition.

The next thing of interest was the type of incision in which the rupture occurred most frequently. It was, in our experience, the split rectus incision. The kind of incisions involved and the number of times in which disruption took place in each type were as follows:

Split right rectus, upper	28 cases
Split left rectus, upper	8 cases
Median epigastric	3 cases
Split rectus, lower	3 cases
Reversed Kammerer	2 cases
Transverse	1 case
Median suprapubic	1 case
Total	46 cases

* Read before the New York Surgical Society, November 8, 1933.

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It can be seen that in our series thirty-nine out of forty-six disruptions took place in the upper abdominal incisions. We hesitate to do more than call attention to this as we cannot give the absolute number of times upper or lower abdominal incisions were carried out on our service. It is perhaps opportune also to draw attention to wound disruption taking place twice in reversed Kammerer incisions. One has felt that some of the disadvantages of this incision were amply compensated for in the security it offered as to wound healing. We have no cases showing rupture following the McBurney incision.

Chromic catgut was the suture material used in all of these patients. The abdominal wall was sutured in layers with a running suture. Silk or silk-worm gut was not used except for skin apposition. No retention sutures were used in sewing up the abdominal wounds. This complication occurred solely in wounds in which absorbable gut was used. It may be said that it was usually the surgeon's observation that no evidences of catgut were observed by him at any secondary operative procedure following disruption.

In the analysis of this group of patients it was important to see if there was any relation between the disease for which the patient underwent operation and the incidence of disruption. While the number of cases is rather small the frequency of failure of wound healing in certain conditions was of interest. The operative diagnoses with their frequency of these patients were as follows:

(1) Carcinoma stomach, 6 cases	pancreas, 2 cases	sig-
moid, 1 case, unknown origin	1 case	Total
(2) Chronic ulcer of stomach or duodenum		10 cases
(3) Gall-bladder disease		8 cases
(4) Appendicitis		7 cases
(5) Stab-wounds of abdomen		7 cases
(6) Perforated ulcer of stomach or duodenum		3 cases
(7) Chronic intestinal obstruction		3 cases
(8) Ruptured typhoid ulcer		2 cases
(9) Ruptured spleen		1 case
(10) Gunshot wound of abdomen		1 case
(11) Abscess of liver		1 case
(12) Tuberculosis of peritoneum		1 case
(13) Undiagnosed abdomen		1 case
Total		46 cases

It is apparent that the largest group occurred in cases suffering from carcinoma of an abdominal viscus. This tends to confirm the usual surgical impression that diseases in which there is great loss of weight and strength with resultant cachexia may heal more slowly than wounds in better nourished patients and when subjected to unusual intra-abdominal pressure the wound may give way in part or in its whole extent. The frequency also of disruption in patients with ulcer of the stomach or in patients with gall-bladder disease or appendicitis we believe is due to the factors of vomiting, hiccough-

ing, distention, and infection, rather than to the patient's state of nutrition before operation

These latter factors are probably the most frequent and direct causes of abdominal disruption. They cannot be separated completely from each other. It is apparent that while a patient may suffer predominantly from one of these, any other may be and often is present.

In discussing the complications which occur post-operatively and are looked upon by the surgeon as being the predominant or active factors in disruption, it is difficult to offer other than a mixed group in which symptoms of disease entities may be enumerated alone or together. These conditions, as has been mentioned before, may be present in any combination. They were mentioned as being the important factors in the abdominal wound disruption, by the surgeon in charge, with this frequency:

Infection	17 cases
Coughing (pneumonia, 5 cases)	17 cases
Vomiting	9 cases
Distention or obstruction	4 cases
Hiccoughing	4 cases
Retching at lavage	2 cases
Difficult sew-up	2 cases
Patient getting out of bed	3 cases
Not known	3 cases

Infection as described in these wounds was generally of a gross character. There was nothing significant in the bacteriological reports, which were few in number. In certain of these wounds the infection involved also the peritoneal cavity. The relative frequency of infection in these cases may be due to the fact that the primary operation was on a hollow viscus and the wound a contaminated one. Adequate drainage at the primary operation did not prevent gross wound suppuration and disruption in these cases. It was possible that many of these wounds could have been markedly infected and yet separate only partially. The greatly increased strain of coughing, hiccoughing, or vomiting, was, however, more than the wounds could withstand.

Coughing was an active factor in more than one out of three disruptions. In five cases, bronchopneumonia or lobar pneumonia were found by examination but in the greater number no definite signs of lung pathology could be elicited. Coughing, as described here, was noted for its frequency and severity. Unproductive for the most part, it often culminated in the severe attacks of pain that indicated wound damage.

Vomiting, hiccoughing, and retching are also common factors. These untoward symptoms were treated by the usual methods of therapy of which gastric lavage was the most frequent. We may note here that in two patients it was thought likely that the severe retching and struggling during the passage of the stomach tube was distinctly related to the wound accident. On this account a more frequent use of the Levin tube in those patients suffering from gastric dilatation might relieve them without imposing an unusual pressure on their weakened wounds.

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Hiccoughing was of a severe type in four of these patients. Beginning generally on the first post-operative day it was from the onset uncontrollable. Hiccoughing in these cases lasted five, eight, eleven, and twelve days respectively. It was not any one attack of hiccoughs that seemed to disrupt the wounds but the effect of hiccoughing was accumulative. Once the peritoneal wound was broken, the wedge of intraperitoneal contents widened the gap at each succeeding attack. The wound condition was not recognized often until the sutures had been removed and the covering skin disrupted.

Distention is, too, of import directly or indirectly. Unrelieved, it generally caused disruption when some other propulsive factor such as coughing or vomiting was present. While distention usually precedes disruption, one cannot lose sight of the fact that the disruption may occur, on the other hand, prior to the distention. The extrusion of intestine through a small gap in the healing wound may give rise to an unsuspected intestinal obstruction. Unrelieved distention, therefore, may be the result rather than the cause of

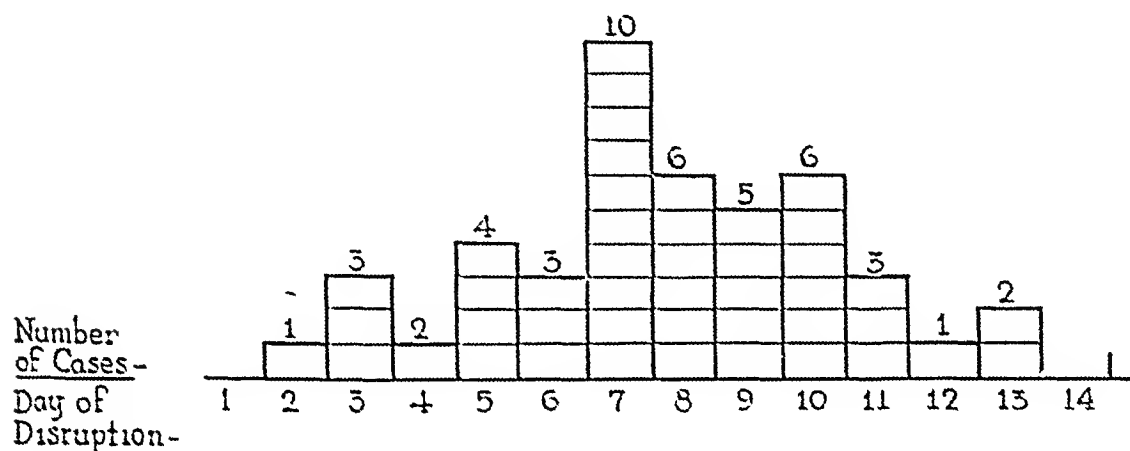


Diagram 1—Showing the number of cases and day of disruption

wound disruption. On several occasions the operator reported great difficulty in closing the abdominal wound. Retraction of the transversalis fibres or failure to include them in the peritoneal layer predisposed to defective wound closure. This may result in very early extrusion of omentum or intestine. Very early disruptions may be related to this condition. The ordinary running suture should be amplified or protected with relaxation sutures suitable to the operator and the wound that is being repaired.

The time of disruption may be illustrated by Diagram 1. The blocks represent the number of cases disrupted on any given post-operative day.

Those cases reported as early as the second or third day are probably examples of that group that have defective wound repair at the time of their sew-up with immediate post-operative wedging of omentum or intestine. The larger group noted here occur after the sixth day post-operative. This may possibly be explained by the fact that at this time the sutures have been removed in many of the cases and the defects in the wound healing may then be noted following the separation of the skin as it occurs. Statistically, the mortality was lower in the group of cases in which dis-

ruption takes place before the fifth day. This may be due to the fact that in these cases the wound accident is diagnosed very soon after its occurrence and steps are taken to repair it. On this account it might be well to examine the symptoms or physical signs presenting themselves in this condition.

'Pink staining,' as it is often noted on the dressing, may be one of the earliest significant facts in wound rupture. The watery discharge is noted in greater or lesser amounts. It has been noted as soaking through the overlying dressing into the covering sheets. This pink, watery discharge of peritoneal fluid should not be disregarded if early diagnosis of disruption is to be made. It is not unwise in suspected cases to remove a few skin sutures and inspect the deeper layers, to see if disruption has taken place or is imminent. It is quite apparent after a study of the case histories of many of these patients that pink discharge was observed on the dressings for days before the wound condition was appreciated. Since early diagnosis reduces the mortality of this condition, we cannot too strongly indicate the significance of this pink peritoneal discharge in the overlying dressings.

Pain is the next symptom of importance in this regard. Referred to the wound and coming on after a severe attack of vomiting, or coughing, it is usually of great severity. The patient's condition in which rupture of the wound occurs suddenly suffers from that group of symptoms that may be described as shock. Disruption probably occurs acutely in most cases. In some patients the condition is slower and the final breaking down of the wound may disclose abdominal contents already adherent to the wound edges and to each other. It is probable that the very early ventral herniæ noticed in the follow-up clinic may be examples of this group of slow disruptions in which the skin and subcutaneous tissues healed without disclosing the deeper wound defect.

The treatment carried out on the discovery of the disruption was as follows:

(1) Secondary suture	30 cases
(2) Strapping or packing, or both	16 cases

Secondary suture is the method of choice and was used in the acute disruptions unless there were distinct contraindications. The method usually used was to appose the wound edges by through-and-through silkworm-gut or silk sutures going through all layers. Local, general, or spinal anæsthesia may be used, depending on the patient's condition. Although attempts were made successfully in some of these cases to resuture the wound in layers with absorbable gut, we think that the apposition of the wound edges by through-and-through nonabsorbable sutures is the method of choice.

Strapping with or without packing was used in about one-third of the patients. It was used often in those cases in which disruption had taken slowly and when discovered the extruding contents were already adherent to the deeper wound tissues. It was also used in certain cases of severely infected wounds in which the surgeon hesitated to replace within the appar-

ently uninfected peritoneal cavity, omentum or intestine already grossly exposed to the wound discharges. It was also used in a few instances when the surgeon felt that the patient was in no condition to stand any secondary operative procedure.

It is quite remarkable to observe the powers of these wounds to heal in spite of their earlier rupture. The presence of wound infection is no bar to wound healing following secondary operation. Appropriate drainage must be instituted in these cases to take care of the wound discharges lest the wound breaks down again. It is interesting to note that in only two of these cases requiring secondary suture did the wound fail to heal and a rerupture occur. Both of these were subsequently controlled by strapping.

Of the twenty-eight patients who recovered from this serious complication, it was noted on subsequent follow-up examination that the usual result was one of post-operative ventral hernia. Only in a few cases could it be said that the wound had healed firmly without evidences of herniation.

Mortality—Out of thirty-six cases of abdominal wound disruption with protrusion of viscera, there were fifteen deaths, or 41 per cent.

Out of ten cases of abdominal wound disruption without protrusion of viscera, there were three deaths, or 30 per cent. Death, therefore, occurred in eighteen out of forty-six patients, a mortality of 39 per cent. The predisposing cause of death is related to the disease for which the patient was administered often a chronic one with attendant cachexia. The immediate causes of death in these patients were post-operative pneumonia, peritonitis, and shock.

In twenty-eight cases treated by secondary suture, there were eleven deaths.

In eighteen cases treated with strapping and packing, there were seven deaths.

The approximate mortality in both of these groups is 39 per cent, and while secondary suture is the procedure of choice, the more conservative closed method is to be used when indicated.

DISRUPTION OF ABDOMINAL WOUNDS *

BY WILLIAM CRAWFORD WHITE, M D

OF NEW YORK, N Y

FROM THE ROOSEVELT HOSPITAL

THIS subject has been reviewed under several titles separation of abdominal wounds, evisceration, prolapse of intestine, eventration of wound, and disruption of abdominal wounds In this paper we intend to confine our discussion to post-operative abdominal wounds, in which the wound edges have separated enough to permit inspection of some of the contents of the abdominal cavity

In our experience, this complication has not occurred after intermuscular, Pfannenstiel, costal or transverse incisions We rarely employ the last two incisions but the muscle-splitting intermuscular and the Pfannenstiel incisions are in constant use Our accidents have been confined to the three types of vertical incision, namely the mid-line incision, the split rectus, and the laterally retracted rectus

We have thirty cases to report, twenty-eight from recent years, and two additional that the writer remembered from his internship Sixteen of the patients died, a mortality of 53 per cent There has been no attempt to speak of percentage The number of abdominal operations at our hospital has remained about the same, with slight variation in the incidence from year to year In 1931, there were 406 vertical abdominal incisions with seven disruptions This started me on this investigation, as in other years we had one to four per year

Madelung,¹ in 1905, declared that the most common site of disruption was in the lower abdominal wound Our experience has been to the contrary Two-thirds of our disruptions occurred in upper vertical incisions while the other third occurred in middle and lower vertical incisions Some thought on the subject must convince one that this observation is in conformity with the anatomy and physiology of the abdomen Many of the factors to be discussed later are common to the upper and lower abdomen But in two respects the upper abdomen differs distinctly from the lower In the first place, the fibres of the posterior sheath of the upper rectus run transversely, and, because of this, it is more difficult to retain the suture in the posterior sheath and peritoneum Many times, at operation, we have seen the suture pull out between the transverse fibres, as some sudden tension was applied In the second place, the costal movement causes increased tension on the vertical wound every time there is an inspiration, while this is not felt in the lower abdomen It is logical, therefore, to believe that sudden violent respiratory movement could be an important factor in disruption of upper vertical abdominal wounds

* Read before the New York Surgical Society, November 8, 1933

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Predisposing Causes—It is well recognized that the body tissues in the aged the decrepit the malignant and the jaundiced do not heal so rapidly or so well as in the average person. Necessarily one must be on guard against these handicaps. Thirteen of our thirty cases were in patients over fifty-five years of age. Five of our thirty cases were suffering from malignant disease and one had an icteric index of 90.

Another predisposing factor for which it is difficult to give a name is that body-tissue condition which induces *early dissolution of catgut*, long before the theoretical absorption time. In these no obvious infection is present as a factor, so that it has induced me to believe that individuals vary in their property of catgut dissolution.

Our treatment of the rectus muscle has consisted of two methods. In the first method the rectus muscle is split at the junction of the middle and inner third of the muscle, while in the second method, the rectus muscle is retracted outward after it has been freed from the sheath. In neither of these methods is the nerve supply to the rectus muscle seriously damaged so that we have not considered nerve injury to be a predisposing cause.

Of the thirty cases two had median incisions, six had muscle retraction, and twenty-two had splitting of the rectus muscle fibres. While these figures would seem to point a finger of scorn at the split rectus incision, it may be said in rebuttal that the split rectus is used much more than 75 per cent of the time. Rather, the retraction of the rectus muscle has proved disappointing as a method, for it has not lived up to the hope that it would prevent disruption or post-operative ventral hernia.

Exciting Causes—Many abdominal wounds have healed after a rectus incision in which the closure has been made with plain catgut. In such instances the patient was very fortunate to escape the common exciting causes of disruption: chronic cough, hiccough, violent sneezing, great distention and undue abdominal strain.

Pneumonia or acute atelectasis does not seem to be an important factor but the *constant cough* that is associated with respiratory infection has been felt to be the most important factor in six of our patients.

Hiccough which persisted in spite of treatment also was definitely the causative factor in one patient.

Sneezing is perhaps a more violent action than either coughing or hiccough. One of our patients gave a violent sneeze and immediately noted a peculiar sensation in the abdominal wound. On dressing the patient a loop of small intestine was noted in the disrupted wound.

Distention is common after abdominal operations, but usually it is quickly relieved by appropriate methods. However, we are occasionally troubled by some patients who develop great distention. In three of our cases, the distention became so marked that we felt it was the chief exciting cause.

Undue abdominal strain occurs when restraint is required for a delirious patient or when the patient gets out of bed and walks soon after operation.

One patient in a straight jacket developed a disruption while two patients who got out of bed in delirium and walked disrupted a few days later.

We have not thought that vomiting was a definite cause. It is such a general sequence that it would be difficult to isolate it as a factor. Furthermore, the abdominal wound has its maximum suture strength immediately after operation when vomiting most commonly occurs.

Infection in an operative wound causes destruction of tissue, thrombosis of blood-vessels and changes the body tissue from an alkaline to an acid medium with consequent interference with wound repair. In eight of our cases such destruction from infection seemed to be the chief cause.

Pathology—The separation of the skin and subcutaneous tissue is of but little significance. We have seen many cases of abdominal-wall infection confined to the subcutaneous fat, in which the skin edges were deliberately separated by the dresser, with no permanent damage to the firmness of the abdominal wound.

In many there is a slow and quiet development of the disruption. Ries² speaks of the distinct snapping sound that has occurred with the breaking of the catgut and the subsequent disruption. We have never been conscious of such an episode. But in numerous cases we have been warned of danger by a *profuse blood-tinged serous discharge* on the dressing. Often it is so great that the patient will complain about the warm fluid that is running down over his abdomen. Two cases will illustrate this first stage.

The first patient (No. B30344), on the fifth day began to discharge a profuse serosanguinous fluid from the abdominal wound, but the skin appeared to be intact. Nevertheless, on the next day, she was operated upon again. The entire wound beneath the skin had separated while small intestine was found immediately beneath the skin. The silkworm tension sutures were intact but had cut through the anterior rectus fascia. The chromic catgut as well as the plain catgut sutures had separated. The second patient (No. C20573), had a mid-line incision, below the umbilicus, exposing both recti. On the fifth day, a serosanguinous discharge was noted on the dressing. This was changed and within an hour the discharge had markedly increased. At examination by the house surgeon, a probe was passed between the skin edges, only to drop into free space without resistance. An immediate emergency operation was performed. It was then noted after the skin edges had been separated that the anterior sheath of the rectus had completely separated, the catgut had completely dissolved, and the silkworm tension sutures had torn out of the fascia. The muscle had separated to expose the peritoneum which was intact except for an opening two centimetres long from which the fluid exuded. There was no abdominal wound infection.

It is astonishing to note how quietly the final stage may occur and with what freedom from pain or discomfort. The profuse discharge of bloody fluid is not always present in sufficient amount to cause notice, so that the complete disruption may be discovered only after the dresser has removed the gauze pads.

The process of disruption is not usually understood. It is the common belief that the separation of the wound is a process that occurs simultaneously throughout the wall. To the contrary, disruption is usually a process that occurs slowly and in steps. Ries has pointed out the following facts. Exam-

mation of the wound edges, immediately after disruption, will show signs of fresh bleeding in the skin edges but nowhere else. The peritoneum, muscle and fascial layers will be oedematous, matted together and possibly covered with a glistening and smooth granulation tissue. The appearance is that of chronic inflammation with no evidence of recent injury. This is supported by the clinical data. Our records abound with notes to the effect that the silk skin sutures were removed and that shortly afterward the wound opened and the intestines eviscerated. The skin suture is usually strong enough to hold the skin together. The subcutaneous tissue long since had separated so that the disruption is completed when the silk is removed from the skin, and the sole adhesive material is some new granulation tissue between the skin edges. If the deeper tissue separated at the same time as the skin edges, not only should there be some fresh bleeding but the various layers would not have become adherent and overlapping, with fibrinous exudate over all.

The methods of suture have varied in different decades. In this group the common practice has been to close the wound by layers. Plain or chromic catgut has been used for the peritoneum and posterior rectus sheath, the same for the anterior rectus sheath, with tension sutures of silkworm or dermal through the skin and anterior fascia, and fine silk for the skin. Some of our staff have placed their trust completely in catgut, without any tension sutures. One such case recently demonstrated the risk when dependence on fascial sutures alone is made, with either catgut or silk. Brettauer³ speaks of the deep disruption that occurs when the stitch holes are all made in a row in the fascial border. It reminds one of postage-stamp perforations and tears with the same ease. In this case all the chromic sutures were intact but the fascia had torn along the row of perforations. Others of the staff have felt the need of the tension suture to protect the wound against any sudden additional strain. This tension suture has been used as a single or a double loop (figure of eight) through the anterior rectus fascia and skin. Silkworm, in my experience, varies in tensile strength and brittleness, while dermal suture material has uniform tensile strength, is not brittle, and is less irritating to the skin. This has induced most of us to discard silkworm in favor of dermal suture material.

Years ago it was the practice to close abdominal wounds with through-and-through sutures. When suture by layers came into vogue, the former method gradually went into the discard. During the treatment of disruptions we noticed that the wound edges were so matted together and so friable that secondary repair by layer was practically impossible. We were then forced to return to the former method of closure by suture through the entire wall. We took braided silk No. 20 because of its strength, pliability, and lack of irritation. The sutures were carried through the skin, fascia, muscle and peritoneum on one side and reversed on the other side. These were placed one-half to one inch apart. The resulting wounds healed promptly and firmly, with no other suture. Such success has induced us to return, with

satisfaction, to the same simple procedure in the fresh wounds of doubtful cases, especially in the upper abdomen, and after gastric surgery

It is well recognized that all the predisposing and exciting factors may not uniformly be avoided in an active surgical service. As a preventive, we believe that too much faith should not be placed in catgut. We believe that the chief protection against undue strain and disruption lies in nonsoluble tension suture of dermal or braided silk placed at short intervals. We have seen intestine protrude between the sutures when too wide apart. If undue tension is anticipated or when in doubt, the braided silk tension suture should be passed through the entire abdominal wall, and placed at short intervals. Perhaps one reason for the success of the later method as opposed to the suture by layers, in debilitated folk, is that the circulatory disturbance may be less with consequent improved wound repair.

Furthermore, since the common period of complete disruption occurs on the eighth to the tenth day, it is well to leave in the tension sutures until the twelfth day. In those cases that develop deep separation of the wound, the superficial separation may be prevented, and thus the patient be left with a post-operative hernia instead of a disruption.

CONCLUSIONS—Disruption is essentially a sequence of the vertical rectus or median incisions.

It is most common in the upper rectus wounds.

• The predisposing causes are *senility, decrepitude, malignancy, jaundice,* and a peculiar body-tissue function that dissolves catgut earlier than usual.

• The *exciting causes* are constant coughing, hiccoughing, sneezing, distention, undue abdominal strain, infection.

The *common pathology* consists of gradual separation of the peritoneum, fascia, and muscle with a completion of the process a few days later, usually on the eighth to the tenth day.

The chief warning of this accident is a profuse serosanguinous discharge which appears often before the final stage.

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DISRUPTION OF ABDOMINAL WOUNDS*

BY CHAS GORDON HEYD, M D

OF NEW YORK, N Y

FROM THE NEW YORK POST GRADUATE MEDICAL SCHOOL

DISRUPTION of abdominal wounds has an extensive list of synonyms. The condition is referred to as post-operative eventration, post-operative rupture of abdominal incisions, devulsion of abdominal incision, bursting of abdominal wounds, broken-down abdominal incision, secondary dehiscence of abdominal wounds and spontaneous post-operative evisceration.

The condition is not rare and occurs in the practice of our best surgeons and with the most approved technic. Briefly, there is a spontaneous rupture or separation of the various layers of an abdominal wound with varying degrees of eventration of abdominal contents. In 1925, Sokolow reported 614 cases, with a death rate of 31 per cent. Starr and Nason, in 2,455 laparotomies, had fifteen ruptures or 61 per cent, and it is interesting to note that 40 per cent of these ruptures occurred following operations for carcinoma and that out of 135 operations performed for carcinoma there was an incidence of disruption of the wound of 44 per cent.

In 2,145 personal laparotomies I have had four ruptures of the wound, representing one to 536, with one mortality. In 1932, there were 1,000 laparotomies at the Post-Graduate Hospital, with four cases of disruption of abdominal wounds, representing one to 250, with one death, a mortality of 25 per cent.

It is reported that eventration of intestinal contents occurs more frequently in incisions made in the lower abdomen and that there is a preponderance of three to one in females over males. In surveying the operative experience of the combined surgical services at the Post-Graduate Hospital for the past three years we have found that spontaneous rupture of abdominal wounds has occurred on all of the services and that there is no startling predilection between upper and lower abdominal incision, or between the sexes. It is obvious that the gynecological service will see cases of disruption of wounds almost entirely in the lower abdomen while in the more widely distributed services of general surgery the majority would be in upper abdominal incision. All of my personal cases were upper abdominal wounds. Yet, from reading the literature, there is a preponderant number of ruptures in the lower half of the abdomen in the proportion of about six to four.

It has seemed possible to distinguish three types of disruption of abdominal wounds. The first type is represented by an individual who has enjoyed a relatively uneventful convalescence. Inspection of the wound has at no time revealed any noteworthy change except possibly for a degree of temperature

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after the first three days. At the operation no drainage was introduced. Some time shortly after the removal of the retention sutures or within twelve hours the patient coughs or strains, the abdomen feels hot, the dressings are saturated and upon removal of the dressings there is an eventration of omentum and intestines. Almost identical with this type is the patient that has had drainage instituted for the prevention of serum or bile secretion. These patients, as a rule, are in good physical condition and there has been nothing in the surgery nor in the condition itself to cause undue trauma to the wound. The patient complains of pain on the second or third day, in excess of that usually experienced. If there has been a subcutaneous drain for the relief of serum, the dressings are saturated with yellowish stained fluid, occasionally slightly blood-tinged, shortly after the retention sutures are removed the wound opens up throughout its entire extent, the omentum is found in the wound and the intestines lying free on the anterior abdominal wall. Inspection of this wound shows no element of wound sepsis. The catgut may be completely dissolved or at least remaining only as a few stray strands. The edges of the wound show no evidence of repair.

The second type is characterized by the knuckling of a portion of small intestine through a gap in the peritoneal closure line. The patient has been unsatisfactory surgically, has taken a bad anæsthetic, with incomplete abdominal relaxation, at the time of closure of the wound. There has been more vomiting and more distention than usual. The wound, if it has not been drained, appears apparently normal. For some days the skin may remain absolutely intact, and it is only when the symptomatology of intestinal obstruction becomes clearly defined that the possibility of extruding of bowel into the wound is considered. Upon opening up the skin wound there is a partial or complete obstruction of the small intestine with some protrusion of a portion of the omentum, but eventration in the real sense of the word is rare.

The third type occurs in wounds that show lack of adequate healing. The skin edges are everted, œdematous and red. There are gaps between the sutures. The sutures cut through. There is a peculiar cadaveric odor to the dressings and there is a constitutional background of nephritis, diabetes, carcinoma or jaundice. Upon removal of the restraining sutures eventration is usually only partial and can be controlled by packing and strapping of the wound. In this group there is evidently an absence of normal tissue resistance with a secondary element of infection.

The etiology of disruption of abdominal wounds is obscure and various explanations have been made, such as failure of suture material, strain, coughing, infection, over-acidity of tissue, *etc.* These criteria are invalid because in a typical case the characteristic notation as read from the history is as follows: "Sutures removed on the twelfth day and patient coughed, whereupon the skin wound separated and omentum and intestines protruded." Examination of such a wound reveals little or no evidence of catgut and infection is certainly absent.

Freeman is most emphatic in believing that disruption of abdominal

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wounds is due to an inadequacy of peritoneal closure, resulting in the propulsion of omentum through defects in the line of peritoneal closure, and that once this mechanism is initiated the omentum reacts, becomes œdematous, exercises a disruptive force in all directions and awaits only some additional impulse such as the removal of the stay sutures or turning in bed, or a coughing spell, to produce eventration

The presence, however, of certain types of infection must also be considered. Rapid proteolytic digestion of catgut by the products of infection may possibly be an explanation for the fact that twenty-day chromic catgut is dissolved within four days and before fibroblastic production has begun. Doctor Erdmann is of the opinion that dehiscence or separation is not primarily due to catgut but rather to the too rapid absorption of catgut due to tissue hunger, as in the majority of these cases the patient is below par physically as well as being deficient in hæmoglobin. Starr believes that early discontinuance of general anæsthesia with retching and straining before the reinforcing effect of the sutured fascia is obtained results in rents in the peritoneum and the forceful propulsion of omentum or intestine. On re-suture of the wound healing ordinarily takes place. A possible explanation for this paradoxical condition of failure of the primary suture and success in the secondary suture depends upon the physiology of wound healing. Howes and Harvey have drawn attention to the fact that for the first four days union is at a minimal rate, after which time fibroblastic production increases up to the twelfth or fourteenth day, and that the strength of a wound up to five days is represented entirely by the holding powers of the suture. It is evident that the trauma incident to the secondary suture is responsible for a marked increase in the growth of fibroblasts.

It is almost the universal practice at the Post-Graduate Hospital for the various operators to use non-absorbable retention sutures. These are removed ordinarily any time from the tenth to the fourteenth day.

If one may hazard a personal opinion it is that prevention may be largely enhanced by the application of the following surgical principles: (1) complete hæmostasis of all abdominal wounds, (2) relaxation of the abdominal parietes when closure is being performed, (3) the avoidance of undue trauma, (4) the elimination of dead space which makes for subsequent hæmatoma or serum collection, (5) an absolutely aseptic technic, and finally (6) accurate coaptation of the peritoneum. It has seemed to the author that suture of split muscle fibre by either No. 1 chromic or plain catgut is a valuable point in the prevention of this condition. The muscle tissue is primarily concerned with the conditions that precede fibroplasia and the development of fibroblasts.

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DISCUSSION—DR CARL EGGERS said that the records of the Lenox Hill Hospital showed ten cases of disruption during the last five years. This does not include private patients. Four of these patients died, or 40 per cent. In those who died, however, it was not the disruption as such which was responsible for the high mortality, but the original underlying causes which had initiated the disruption either peritonitis, pneumonia and severe cough, or associated complications such as general sepsis, suppurative parotitis *etc*. There was always a combination of pathological conditions. He further reported a series of ten personal cases which occurred in patients ranging in age from infants with hypertrophic pyloric stenosis to very old people. In this group there was a mortality of 20 per cent. He felt that the interest in the subject lay in the disruption occurring in clean cases which in the majority of his patients took place on the ninth day. As to the various causes he agreed with the essayists.

Referring to Doctor White's suggestion regarding the use of through-and-through silk sutures, Doctor Eggers said he used those in selected cases, especially in men with an obtuse epigastric angle in whom there is a rigid chest wall with a tense epigastrium. Even in those cases, however, he feels that a layer suture should be added in order to get proper peritoneal apposition. Through-and-through heavy silk sutures carry a certain danger in that they may catch a piece of omentum or gut while being tied, or by the intraperitoneal irritation they produce, adhesions and later obstruction may develop. For these reasons and also because of the greater likelihood of post-operative ventral hernia the layer suture now in use should not be abandoned, but in selected cases supplemented by the through-and-through suture.

It is surprising how smooth the convalescence of an uncomplicated disruption case may be. It has been his custom to do an immediate secondary suture in some of the uncomplicated cases, at times without any anesthesia, by passing heavy through-and-through sutures from within outward and tying them while a finger under the suture pushes back the omentum or gut. In all complicated cases, however, he feels that the entire procedure of suturing in the operating room, with the necessary exposure and anesthesia, unfavorably influences the prognosis. In these cases he treats the patient in bed by reducing the intestines and omentum, freeing the newly formed adhesions from the peritoneal margins, and applying an iodoform or plain gauze tampon. The wound margins are then firmly strapped with two-inch adhesive plaster, allowing the ends of the tampon to project above and below. The tampon should be changed infrequently. After the complications had subsided a secondary suture was done in some of the cases, while in others strapping was continued until healing was complete.

DR HAROLD NEUHOF remarked the fact that in three of the papers, reference had been made to the use of silk in closure, reporting a low percentage or absence of

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disruption with the use of non-absorbable material. This fact cannot be ignored and it appeared to the speaker that the stage had been reached in which those who use catgut for abdominal wall closure must prove that it is as adequate as closure with silk. If the complication of disruption was infrequent and its mortality not high, the problem could perhaps be passed over, but the evidence presented should be accepted and a fair trial of closure with non-absorbable material should be given. If one wished one could limit the use of silk to the closure of the aponeurosis in clean cases, the use of silk throughout being reserved for those who desire to use the meticulous technic which a universal use of silk for ligatures and sutures involves.

He doubted if the whole story of disruption of wounds had been told that evening. All the reports were concerned with gross disruption accompanied by evisceration. They did not know what proportion of all cases that are operated upon have partial separation at an early date. The question extends beyond the fact of obvious disruption noted within the first week or ten days after operation. Post-operative incisional hernia may well be referable, in part at least, to rupture with evisceration whose results may not be noted until months after operation.

As to the question of treatment, Doctor Grace, in particular, had noted the two methods of treatment of gross disruption namely suture and packing. Other presenters also referred to treatment without offering evidence of the advantages in one or the other method. After having seen some of the vicissitudes connected with closure by suture the speaker's own choice was the use of packing. The manoeuvres involved in bringing a patient to secondary operation must often produce more evisceration by the time one is prepared to make the secondary suture. The patient is lifted from the bed, placed on a stretcher, taken to the operating room, moved to the operating table, and an anæsthetic is often administered. This succession of events upon several occasions to his personal knowledge had resulted in far greater evisceration than existed at the time it was first noted. His procedure, which does not involve removal of the patient from bed, consisted in administering a large dose of morphine after which whatever is prolapsed is gradually replaced within the abdominal wall and packed in place with iodoform gauze. Over this the abdominal wall is tightly strapped with adhesive. The gauze pack is not removed until a week or ten days have elapsed at which time a clean wound exists. This can be tightly strapped or sutured. In cases of evisceration in the presence of a drained wound, the site of drainage is maintained during the time that the remainder of the disrupted wound is packed. Doctor Colp in his paper had stated that in his series hernia had regularly followed the treatment of disruption by packing. In Doctor Neuhof's cases some of the patients had developed hernia and others had not.

DR. JOHN A. MCCREERY said that it was evident that the condition from which the patient originally suffered was of primary importance in the development of disrupted wounds, as all the papers had stressed the importance of the wasting diseases in this condition. He was somewhat surprised that so large a number of cases developed in lower abdominal incisions. It had been his impression that disruption would be much more frequent in the upper abdominal incisions on account of the increased wound tension in that area. Like all surgeons, he had had the experience of examining disrupted wounds a few days after operation and finding a complete disappearance of the chromic catgut. However he had not yet brought himself to believe that the silk suture was the material of choice. There was no question however of the value of tension sutures and he believed that with the increased use of these, putting them more closely together than was usually done, disruptions would be less frequent, although one might see more post-operative herniæ.

DR. EUGENE H. POOL called attention to the stitch valuable for closing the deep layer in upper abdominal incisions which he had described in the American Journal of

Surgeon of August, 1931 as the "Zipper Stitch." The posterior sheath of the rectus muscle above the semilunar line is made up of fibres from the aponeuroses of the internal oblique and transversalis muscles. These are intimately fused into a single layer in close apposition to which are the transversalis fascia and the peritoneum. In closure of a vertical incision through the rectus muscle the original suture is not of the peritoneum alone but of these combined structures. Apposition of the edges is often difficult. The failure of this layer to hold is the usual cause of the large percentage of incisional hernia in these incisions and the occasional occurrence of evisceration. When this distressing complication threatens, the patient complains of discomfort in the region of the wound, and vomiting. Inspection of the wound may be negative or show a fullness, separation of the skin edges results in a considerable flow of salmon-colored fluid. This, in his experience, always indicates a separation of the deep layer with a knuckle of intestine projecting between the edges. Under these conditions the patient should be taken to the operating room, the wound opened and resutured. If this is not done evisceration is likely to occur.

The anatomical structure of the posterior sheath is largely responsible for the ease with which this layer tears apart. The fibres of the aponeuroses of the internal oblique and transversalis are transverse and therefore offer no support for the sutures. The layers, including the attached peritoneum are taut and the muscles being attached to the costal arch, are pulled outward with each respiratory movement. The widening of the costal arch pulls the muscles, the aponeuroses are proportionately drawn outward together with the attached peritoneum. The pull is resisted only by sutures and the deep ones have little support being placed in tissues whose fibres are parallel to the direction of tension. It is obvious that the strain on this layer must be relieved by sutures placed through more resistant tissues. This is fully appreciated by all surgeons and is accomplished in various ways for instance, by tension sutures through all layers or passing the original suture every third or fourth stitch through the rectus and its anterior sheath. But even in these methods it is often difficult to approximate the deep layer.

He had found the following simple modification advantageous.

A double strand of No. 1 catgut is used. It first picks up the anterior sheath below the lower angle of wound. Having been tied the needle is passed through the rectus and posterior sheath including peritoneum. It is then passed back and forth from one edge of posterior sheath to the other three or four times and *left very loose*. This is the important feature. It is then passed forward through rectus and anterior sheath across wound and inward through the opposite anterior sheath, rectus, posterior sheath and peritoneum. Then the suture is slowly and forcibly pulled taut. The pull should be at a low level and in the direction of the incision, not at an angle. The strain is taken up by the resistant tissues of the anterior sheath, and the posterior sheath and peritoneum come together without strain. The procedure may be termed the "zipper stitch." The suture may be continued with the same stitch, but in a very tense wall it is best to interrupt it. In this case the suture is passed out again and picking up the opposite side of anterior sheath is tied.

DR CHARLES E. FARR said that an interesting sidelight on disruption of wounds was experienced by the First Surgical (Cornell) Division at the New York Hospital during Doctor Gibson's tenure of office. In many hundreds of cases, right rectus wounds either of the muscle splitting or muscle retracting type, were left wide open and packed with the Gibson-Mikulicz tampon. These were all of a very severely infected type with extensive peritonitis or abscess and, naturally, were distended and vomiting after the operation. No sutures were used—neither catgut nor non-absorbable. The results were amazingly good. Evisceration was seen very rarely indeed. At the end of the fourth day the packing was removed and the rubber dam allowed to stay in place. Almost without exception abdominal wounds were clean and healthy with little

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or no slough. Healing took place in three to four weeks and the number of post-operative ventral hernias was no greater than in a similar class of infected wounds which were sutured.

The interesting factors were that the wounds were all severely infected, that they were practically all in a right rectus incision in the lower abdomen, that the patients very commonly suffered from extreme distention and vomiting, and yet eviscerations were very rare. Technically, these wounds were all disrupted and, practically, the patients did remarkably well and the end-results were exceptionally good.

The lesson to be learned from this would seem to be that any form of suturing in the presence of a contaminated wound, especially when accompanied by marked tension is prone to result in tearing out or early absorption of the sutures with disruption and evisceration.

DR ALEXIS V MOSCHCOWITZ said that in this discussion one very important point had been omitted, *viz* that it was the patient who did not do well after operation who was more prone to disruption of the wound. To illustrate, he described two parallel cases with approximately similar pathological conditions and similar operative interferences. The first case did well after operation, had a perfectly smooth convalescence and there was no complication from the wound. The second case did poorly directly after the operation. He developed an acute dilation of the stomach or excessive post-operative meteorism or a mild degree of peritonitis or pneumonia with its attendant cough, *etc*, this is the patient who is prone to disruptions of the wound.

A further point which Doctor Moschcowitz stressed was that he does not rely upon continuous sutures in the post-operative closure of abdominal incisions. At a certain stage of the wound healing, considerable reliance has to be placed upon suture material, therefore, if a continuous suture breaks, there is very little to hold the wound edges together. It is on this account that Doctor Moschcowitz has discarded continuous sutures for interrupted sutures.

DR ALLEN O WHIPPLE reminded the speakers that statistics taken only from the record room files cannot always be accepted as accurate and that unless the total number of cases of laparotomies followed by disruption as determined by actual studies of laparotomies done during a certain period were reported, as in the cases of Doctor Colp's from Mt Sinai Hospital, percentages would not mean very much.

Following Doctor Neuhof's remarks regarding the use of silk as suture material Doctor Whipple urged that silk should not be used in the clinic except by men who had had considerable training and experience in the use of fine silk and men who were jealous of its reputation. If used generally in hospitals by men untrained it will fall into disfavor and acquire a bad reputation.

DR SAMUEL HARVEY of Yale University (by invitation) agreed with what Doctor Whipple had emphasized, that no reliable conclusion can be reached from hospital records. The only way to acquire accurate data is for the surgeon for ten years to note every one of the cases personally. In depending on internes to make the final diagnosis there will be many disruptions that never appear on the records and that the surgeon cannot believe, after ten years, ever occurred. Doctor Harvey did not believe that clinical statistics amounted to anything in this connection. He had the feeling that the solution depended on laboratory work on animals. Doctor Meleney had referred to animal experiments with catgut which do not and cannot duplicate actual operative conditions in man. But it is known that there are two types of animals in whom the absorption of catgut runs to a standard formula so it can be assumed it follows in man. This is better than building up an hypothesis. There are three essential reasons for disruption, four perhaps. There are constitutional alterations which may lead to weakening of the wound. In a young infant, badly nourished, with pyloric stenosis, for in-

stance, the wound is not likely to heal well. With carcinoma of the stomach the wound is not likely to heal well. Senility *per se* has nothing to do with it, but with extreme malnutrition and anemia the wound will not heal well. Without any of these conditions and with wound disruption there are three things to consider. First, how the wound was closed. The speaker favored the vertical incision, but when in a hurry many operators unfortunately do not close the posterior rectus sheath. A bad closure, too fast and too careless, may be the cause of protrusion of a knuckle of gut which pries the wound open. The second thing is too much foreign material in the wound. Thirdly a number of cases are, although unsuspected, infected. An infected wound is not necessarily one in which there is perceptible pus. Every one knows that a large percentage of herniæ are infected. It is unsafe to say by looking at a wound that it is clean or infected. This should depend on laboratory study. The burden of proof is on the person who says a wound is not infected. The fourth point is inaccurate apposition and the presence of hæmatoma which will cause the digestion of catgut. Likewise, the use of large catgut in large quantity introduces a foreign body which acts similarly to an infection of a wound.

DR FREDERIC W. BANCROFT stated that Doctor Whipple had stressed the unreliability of statistics. Doctor Bancroft brought out another possibility wherein statistics might be misleading. If inguinal hernias should be classed as laparotomies, and one hospital should perform a large percentage of these, the percentage of disruption might be very low. He had never seen an evisceration following an operation for inguinal hernia. Inguinal hernia is an opening of the peritoneal cavity and therefore can be roughly classified as a laparotomy. If this be true, one must feel that the anatomical location of the incision is a very important underlying factor. In the repair of upper ventral hernias he has been impressed by the fact that the transversalis fascia and muscle are usually contracted and roll up, lying along the costal margin. In the statistics given by the various writers, the upper rectus or paramedian incision has been the most frequent offender. He felt that incisional hernias occurred more frequently in this type of incision. There must be a fairly large number of cases that are distended immediately post-operative and later develop incisional hernia wherein the evisceration has occurred through peritoneum muscle and fascia but has not happened to rupture the skin. The improvement in results from the use of silk as a suture material may be not so much due to the silk itself as to the fact that the user of it is made conscious of a necessity for gentleness. Silk will break if tied tightly, and only a small bite can be grasped by the clamp. The over-and-over Lembert stitch, pulled up tightly by an over-zealous assistant, tends to produce an evascularity along its line. Too often one assumes after repair that the suture has broken, whereas in reality it may have evascularized a segment of peritoneum and fascia and produced separation by necrosis. Doctor Harvey and Doctor Whipple and his co-workers have shown that in general the smaller the suture material used the greater the tensile strength of the wound. Interrupted sutures tightly tied allow greater vascularity through adhesive surfaces and should therefore be used in preference to a continuous suture.

DR JOHN C. A. GERSTER referred to an observation made during his interne days. A well-known, very able gynecologist had performed a hysterectomy for fibroid of the uterus. It was his custom to use imported silk and interrupted sutures for closing the fascia throughout the entire length of the wound. The wound disrupted on the twelfth day and the entire row of intact sutures with no sign of infection, was visible. The wound looked as if made the day before, all clean tissue—no suppuration. There was no reaction of the tissues toward healing. The use of silk and the kind of sutures did not save that patient from evisceration.

DEATH FROM APPENDICITIS

THE MORTALITY FROM APPENDICITIS AND THE CAUSES OF DEATH FOLLOWING APPENDICITIS

By E. LAWRENCE KEYES, M.D.

OF SAINT LOUIS, MO.

FROM THE DEPARTMENT OF SURGERY, WASHINGTON UNIVERSITY SCHOOL OF MEDICINE THE BARNES HOSPITAL AND
THE ST. LOUIS CHILDREN'S HOSPITAL

MANY of the deaths from appendicitis are preventable. Their occurrence is sometimes attributable to ignorance of or to disregard of the principles of treatment of appendicitis on the part of the attending physician. Often the patient, the patient's family, or the druggist is to blame. At any rate, it seems clear that the causes leading to death from appendicitis are not so widely appreciated as to render fruitless a further study of such causes.

Death from appendicitis, then, is the subject of this paper. The mortality rate of all the cases of appendicitis at the Barnes Hospital and the St. Louis Children's Hospital has been estimated. Certain factors influencing the mortality rate have been observed, particularly age, sex, race, pregnancy, the type of appendicitis, delay in operating, and the administration of laxatives.

Furthermore, an attempt has been made to discover the cause of each individual death of the series. An effort has also been made to determine the ultimate responsibility of appendicitis for each death. The part played by complications and by operative procedures has been analyzed. Finally, the means of preventing deaths from appendicitis in view of the present work have been deduced.

Choice of Material—The study has been strictly limited to chronic appendicitis, acute appendicitis, and appendicitis with peritonitis. Rare types of the disease, such as tuberculosis and carcinoma of the appendix, have not been comprised. Only those patients who underwent an operation for appendicitis or who died from appendicitis without being operated upon were included in this series of cases. Patients on whom an appendectomy was performed incidental to another operation, such as a cholecystectomy, were excluded from the series, unless the appendicitis was determined to be the primary cause of the patient's symptoms.

About 100 or 150 non-operative cases were excluded from the series. The majority of these represented patients who refused operation and left either hospital against advice. Operation was occasionally deemed inadvisable. A fair proportion of the non-operative patients later returned for operation and were included in the series as of the later date. All the non-operative patients who were excluded from the series were alive at the time of discharge from the hospital. None of this class of patients had peritonitis either local or general, all had either chronic appendicitis, subacute appendicitis, or acute unruptured appendicitis. Those non-operative patients who died were included in the series as already mentioned.

The series comprised all appropriate cases of appendicitis at the Barnes Hospital and the St. Louis Children's Hospital during the eighteen successive years of 1915 to 1932. These two hospitals, both of which are in the group affiliated with Washington University, differ only in that patients past the fourteenth year of age are admitted to the Barnes Hospital, while patients fourteen years old and younger are admitted to the St. Louis Children's Hospital. The surgical staff and organization of the two institutions are identical.

General Mortality—The general mortality for the entire group was 3.33 per cent. There were sixty-two deaths among the 1,859 patients.

Mortality at the Barnes Hospital and the St. Louis Children's Hospital Compared—The deaths were about equally divided in number between the Barnes Hospital and the St. Louis Children's Hospital. There were thirty-two deaths at the Barnes, and thirty at the Children's Hospital. Since about four times as many cases of appendicitis were admitted to the Barnes as were admitted to the Children's Hospital, the mortality at the Barnes Hospital was about one-fourth as great as that at the Children's Hospital. The figures were, 2.16 per cent among 1,479 at the Barnes Hospital, and 7.89 per cent among 380 at the St. Louis Children's Hospital.

TABLE I

Mortality according to decades of years, both hospitals. All types of appendicitis are included. The average mortality rate was 3.33 per cent.

Age	Total Number of Cases	Deaths	Mortality in Per Cent
1 to 9	122	15	12.29
10 to 19	609	21	3.45
20 to 29	654	6	0.92
30 to 39	257	5	1.91
40 to 49	114	3	2.63
50 to 59	49	4	8.16
60 to 76	19	8	42.11

Mortality and Age—The mortality by decades was determined, and appears in Table I. A similar determination for the Children's Hospital alone is listed as Table II.

TABLE II

Mortality rate by years, Children's Hospital alone. The distribution of cases among classes is also indicated on the right. The mortality rate at the Children's Hospital was 7.89 per cent.

Age	Total Number of Cases	Deaths	Mortality in Per Cent
1	2	2	100
2	4	1	25
3	10	2	20
4	7	2	28.6
5	13	2	15.4
6	9	0	0
7	22	2	9

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TABLE II—(Continued)

8		24	1	
9		31	3	
10		36	2	
11		53	3	
12		55	5	
13		39	3	
14		35	2	
15		7	0	
Cases				
1-5		36	9	25 0
Class i	1			
Class ii	1			
Class iii	1			
Class iv	5			
Class v	19			
Class vi	9			
6-10		122	8	6 5
Class i	3			
Class ii	5			
Class iii	20			
Class iv	40			
Class v	42			
Class vi	12			
11-15		189	13	6 9
Class i	18			
Class ii	24			
Class iii	36			
Class iv	53			
Class v	35			
Class vi	23			

The youngest patient to die was one and a half years old, the oldest patient to die was seventy-six years of age. The youngest patient to survive was two years old, and the oldest to survive was sixty-nine years of age.

The mortality was highest in the seventh and eighth decades of years. It was also extremely high during the first five years of life. The minimum mortality was that of the third decade of years.

Mortality According to Sex—The mortality rate among males was about three times as great as among females. The male mortality was 5.18 per cent (forty-seven deaths), and female 1.58 per cent (fifteen deaths). The total number of males was 907, females 952.

The male mortality at the Barnes Hospital, 3.63 per cent, was lower than at the Children's Hospital, 9.91 per cent, there were twenty-five deaths out of 685 men at the Barnes Hospital and twenty-two deaths out of 222 boys at the Children's Hospital. Likewise the female mortality at the Barnes Hospital, 0.88 per cent, was lower than that at the Children's Hospital, 5.06 per cent, there were seven deaths out of 794 women at the Barnes Hospital, compared to eight deaths out of 150 girls at the Children's Hospital.

Mortality According to Race—The negro mortality rate was about twice that of the whites. The negro rate was 6 per cent, eight deaths in 134 cases. The white mortality rate was 3.13 per cent, fifty-four deaths in 1,725 cases.

Mortality During Pregnancy—Seventeen women were operated on during pregnancy at the Baines Hospital with one death, a mortality rate of 5.88 per cent. The foetus also died in this instance. Four of these patients were classified in class one, four in class two, three in class three, and six in class four, there was none in class five or class six. A class-two patient represented the sole fatality. The classification into types will be described later. Twelve of the patients were in the third decade of years, five in the fourth. The youngest was twenty-one years of age, the oldest thirty-seven. The duration of the pregnancies ranged from two to six months. None of the patients miscarried.

The one death, that of T. C. S., will be discussed later (p. 60). This death followed pulmonary infarction. The infarcts probably came from infected varicose veins of the leg, and the pregnancy played only an incidental part.

Some of the cases above have been reported by Royston and Fisher in a paper entitled "Appendicitis in Pregnancy."¹ Cases I, II, VII and VIII of their paper are also included in this series. They do not include T. C. S., the patient of this series who died.

Classification of the Cases of Appendicitis—The mortality was found to differ in proportion to the severity of the attack of appendicitis. Accordingly, all the cases were divided into three large groups, chronic appendicitis, acute appendicitis, and appendicitis with peritonitis. Each of these three groups was then subdivided into two sub-classes, in accordance with the plan of J. M. T. Finney, Jr.² The cases were classified as follows:

(1) Class one, chronic appendicitis. This class included patients complaining of chronic pain or discomfort referable to the appendix. If the patient gave a history of one definite acute exacerbation of the chronic appendicitis previous to operation, he was included in this class, if he gave a history of more than one acute exacerbation he was transferred to class two.

(2) Class two, chronic recurrent appendicitis. Included here were patients who gave a history of two or more definite attacks of acute appendicitis in the past, on whom an appendectomy was performed in the interval between the acute or subacute attacks.

Classes one and two, then, comprised what is ordinarily termed "chronic appendicitis." At operation, all the wounds of class-one and class-two patients were closed without drainage.

(3) Class three, subacute appendicitis. This class was limited to those patients on whom an appendectomy was performed either at the very beginning or at the very end of an acute attack, or during a mild acute attack. The appendices of such patients showed little change at operation beyond slight injection and oedema, sometimes with a deposit of fibrin over the serosa.

(4) Class four, acute unruptured appendicitis. Patients suffering from acute appendicitis without peritonitis were placed in this class. At opera-

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tion the appendix was always found to be markedly swollen and injected, covered with fibrin often gangrenous but never ruptured. Cloudy fluid was frequently encountered within the peritoneal cavity, together with injection of adjacent peritoneal surfaces.

Classes three and four comprised the ordinary 'acute appendicitis' without peritonitis. At operation, most of the wounds of the patients of these two classes were closed without drainage; although occasional wounds were drained.

(5) Class five ruptured appendicitis with abscess. For this class patients with an "appendix abscess" were selected. At the time of operation a definite abscess was encountered near the appendix. Sometimes the pus had previously been absorbed and only recent adhesions remained. The appendix itself was often found ruptured though sometimes not in which case it had usually healed after a previous perforation. This class was made also to include those cases of appendicitis with a peritonitis which showed definite signs of localization. At operation, in this class of cases, the appendix was usually removed sometimes not. All wounds were drained.

(6) Class six, ruptured appendicitis with peritonitis. This class included all cases of general peritonitis originating from an acute appendicitis. At operation the appendix was usually found ruptured, and the peritonitis showed little or no tendency to localize. Most of the operative wounds of this class were drained. Classes five and six comprised appendicitis with peritonitis.

Distribution of Cases Among Classes—There were approximately 400 cases in the first class, 300 in the next four, and 100 in the last class. At the Barnes Hospital most of the cases fell into classes one to four, at the Children's Hospital the majority occurred in classes four, five and six. In other words, most cases of appendicitis at the Barnes Hospital were less acute than those at the Children's Hospital. (See Table III.)

Mortality, According to the Class of Appendicitis—There was no mortality in the 126 cases of class one. In class two the mortality was 0.60 per cent., with two deaths in the 331 cases. The mortality rate in class three was about the same as in the previous group, namely, 0.59 per cent., or two deaths in 341 cases. Class four showed a figure of 2.32 per cent., or eight deaths in 345 cases. The relative mortality rate for the first four classes of cases was about the same at the Barnes and Children's Hospitals. The mortality rate for class five was 7.30 per cent., or twenty-three deaths in 315 cases. The mortality rate for this group at the Children's Hospital was one-half again as high as that at the Barnes Hospital. It was 9.02 per cent. at the Children's and 6.22 per cent. at the Barnes Hospital. The mortality rate for class six was very much higher than that of any other, being 27.55 per cent. There were twenty-seven deaths in ninety-eight cases. The mortality at the Children's Hospital, 38.10 per cent., was double that at the Barnes Hospital, 19.61 per cent. The mortality from chronic and subacute appendicitis was,

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therefore, virtually nil. The mortality from acute unruptured appendicitis was over 2 per cent, that from ruptured appendicitis with abscess was 9 per cent, and that from ruptured appendicitis with general peritonitis was nearly 28 per cent.

These figures showed that chronic appendicitis was not a serious disease, that acute appendicitis was rarely fatal, but that peritonitis resulting from acute appendicitis was an extremely grave condition, particularly among children.

TABLE III

Mortality rate according to classes. Class one is chronic appendicitis, two is recurrent appendicitis, three is subacute, four is acute unruptured, five is ruptured with abscess, six is ruptured with peritonitis. Letters a, b, and c denote the inclusion of one, two, and three patients, respectively, who died without operation.

Class	Barnes Hospital			St. Louis Children's Hospital		
	Total Cases	Deaths	Mortality in Per Cent	Total Cases	Deaths	Mortality in Per Cent
1	405	0	0	21	0	0
2	303	2	0.66	31	0	0
3	276	1	0.36	65	1	1.56
4	246	6	2.44	99	2	2.02
5	193	12	6.22	122	11 ^a	9.02
6	56	11	19.64	42	16 ^b	38.10
Total	1,479	32	2.16%	380	30 ^c	7.89%

Mortality and Operation—The question arose as to whether the mortality in this series might have been due to operation rather than to appendicitis. To answer this question, a comparison was made between the first three classes and the last three.

It was found that many more operations were performed in the first three classes than in the last three, the ratio being about eleven to seven. However, the mortality rate in the first three classes was virtually nil, 0.36 per cent, while in the last three it amounted to more than twenty times that, namely, 8.81 per cent. The conclusion was, that appendicitis and not the operation was the chief cause of the mortality.

Mortality and Delay—The cases of acute appendicitis were classified according to the time which had elapsed between the onset of the first symptom of appendicitis, which was almost always abdominal or epigastric pain, and operation. Only the cases of definite acute appendicitis were comprised, that is, classes four, five and six. The mortality rate for each day was calculated, as shown in Table IV. The mortality rate among patients operated upon during the first two days of acute appendicitis was analyzed in Table V. The mortality rate by weeks was also determined in Table VI. The five patients who died without operation were not included in these tabulations. The early mortality rate showed a steady sharp rise which reached a peak of 13.6 per cent upon the third day. More than half the total number of cases fell within this

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time period. The mortality rate then fell somewhat, and rose again after the fifth day (Table IV). The mortality rate was very low during the first day. It was zero for the first twelve-hour period. It was 2.6 per cent for the second twelve-hour period and more than doubled during the third twelve-hour period. It was again almost doubled during the fourth twelve-hour period (Table V). By weeks, the mortality rate was found to rise to a maximum during the third week. Thereafter it remained spotty (Table VI). A special computation was made of the mortality rates of classes five and six. The results appear in Tables VII and VIII. The mortality rate of class five was irregular and inconclusive. It was highest during the first day. Most patients were operated upon on the third day of the disease (Table VII). The mortality rate of class six was nil during the first day. An early peak of 40 per cent was reached on the third day. Later the mortality was exceedingly high. Most patients were operated upon on the second day of the disease (Table VIII).

TABLE IV

The mortality rate of acute appendicitis according to the duration of the disease at the time of operation. Classes four, five and six only are included. Non-operative cases are excluded. The average mortality rate of these three classes was 7.7 per cent.

Duration of Disease at Time of Operation	Cases	Deaths	Mortality in Per Cent
1 Day or Less	162	3	1.9
2 Days	177	13	7.3
3 Days	81	11	13.6
4 Days	51	5	9.8
5 Days	29	2	6.9
6 Days	20	2	10.0
7 Days	31	4	12.9
8 Days	20	3	15.0
9 Days	8	0	0
10 Days	17	0	0
11 Days	10	0	0
12 Days	2	1	50.0
13 Days	3	0	0
14 Days	17	3	17.7

TABLE V

The mortality rate of all early cases of acute appendicitis. Detailed analysis of Table IV.

Time in Hours between Onset and Operation	Cases	Deaths	Mortality in Per Cent
0 to 3	0	0	0
4 to 12	45	0	0
13 to 24	117	3	2.6
25 to 36	86	5	5.8
37 to 48	91	8	8.8

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TABLE VI

The mortality of acute appendicitis by weeks Operative cases only, from classes four, five and six are included The average mortality rate of these three classes was 7.7 per cent

Duration of Disease at Time of Operation	Cases	Deaths	Mortality in Per Cent
1 Week or Less	551	40	7.3
2 Weeks	77	7	9.1
3 Weeks	17	2	11.8
4 Weeks	15	1	6.7
5 Weeks	4	0	0
6 Weeks	3	1	33.3
7 Weeks	0	0	0
8 Weeks	1	1	100.0

TABLE VII

The mortality of ruptured appendicitis with abscess or localized peritonitis, class five The mortality after the eighth day is identical with the mortality after the eighth day of Table IV The mortality rate for this class was 7.3 per cent

Duration of Disease at Time of Operation	Cases	Deaths	Mortality in Per Cent
1 Day or Less	13	2	15.4
2 Days	30	1	3.3
3 Days	39	4	10.3
4 Days	26	1	3.8
5 Days	19	0	0
6 Days	18	2	11.1
7 Days	24	1	4.2
8 Days	17	1	5.9

TABLE VIII

The mortality of acute appendicitis with general peritonitis, class six The mortality rate for this class was 27.6 per cent

A—Operative Cases

Duration of Disease at Time of Operation	Cases	Deaths	Mortality in Per Cent
1 Day or Less	10	0	0
2 Days	43	8	18.6
3 Days	15	6	40.0
4 Days	12	3	25.0
5 Days	5	2	40.0
6 Days	1	0	0
7 Days	2	2	100.00
8 Days	2	2	100.00

B—Non-Operative Cases

6 Days	1	1	100.00
7 Days	1	1	100.00
8 Days	1	1	100.00

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An estimate was also made of the average elapsed time between the initial symptom of acute appendicitis and the time of operation. The average time for class four was found to be forty hours. For class five it was eight days. For class six it was sixty-two hours. The minimum time in class four was four hours. In class five it was eighteen hours. In class six it was nine hours. These figures will be discussed later.

What Influence Had Laxatives on the Mortality Rate?—The histories of all the acute cases, comprising classes four, five and six were searched for definite statements, either that a laxative had been given, or that it had not been given. Of 193 patients who took a laxative, thirty-four died. Of forty-two who took no laxative, only one died. The mortality among those taking laxatives was about eight times as great as the mortality among those who took none. 17.62 per cent in the laxative group, and 2.38 per cent in the "no-laxative" group.

Is the Mortality Rate from Appendicitis Rising?—This question is frequently discussed nowadays. An indication that the mortality from appendicitis may be rising is furnished by certain figures from the Mortality Statistics, United States Bureau of Commerce,³ where it is stated that the total number of deaths from "appendicitis and typhilitis" in the registration areas of the United States rose from 11,321 in 1920 to 14,821 in 1928, and that the death rate from "appendicitis and typhilitis" rose from 11.4 per hundred thousand population in 1910, to 15.2 per hundred thousand population in 1928.

To determine whether the mortality from appendicitis had risen at the two hospitals, the mortality for the nine years of 1915 to 1923 was compared to the mortality for the second nine years of 1924 to 1932. The mortality for the earlier years was 3.07 per cent (twenty-two deaths in 717 cases), and for the later years 3.50 per cent (forty deaths in 1,042 cases). This indicated a slight rise in the recent mortality from appendicitis.

Analysis of the Deaths—An effort was made to determine the actual cause of each death in the series. It was found that general peritonitis caused twenty-one deaths. Abscess of the peritoneum (local peritonitis) caused sixteen deaths. Intestinal obstruction (mechanical) caused six deaths. Infection of the operative wound caused six deaths. Pulmonary embolism caused three deaths. Myocardial insufficiency caused three deaths. Pneumonia caused two deaths. Pylephlebitis, erysipelas, measles, asthma, and leukæmia each caused one death.

Causes of Death among the Classes of Appendicitis—The causes of death were found to be distributed among the six classes of appendicitis in the following fashion. In class one there were no deaths. In class two, pulmonary embolism and intestinal obstruction each caused one death. In class three, infection of the operative wound and erysipelas each caused one death. In class four, infection of the operative wound caused three deaths, abscess of the peritoneum, pulmonary embolism, myocardial insufficiency, pneumonia, and pylephlebitis each caused one death. Class five, abscess of

the peritoneum caused thirteen deaths, intestinal obstruction and myocardial insufficiency each caused two deaths, infection of the operative wound, pulmonary embolism, pneumonia, asthma, measles, and leukæmia each caused one death. In class six general peritonitis caused twenty-one deaths, intestinal obstruction caused three deaths, abscess of the peritoneum caused two deaths, infection of the operative wound caused one death.

Deaths Due to General Peritonitis—General peritonitis accounted for more than one-third of the deaths of the entire series. There were more deaths from this cause at the Children's Hospital, twelve out of thirty, than at the Barnes Hospital, nine out of thirty-two. A high proportion of the very young and of the very old died of general peritonitis. All deaths occurred among class-six patients. The deaths following general peritonitis were usually found to take place within a rather limited period of time dating from the first symptoms of appendicitis. The average duration of life was six days, the shortest period two days, and the longest thirteen days. Calculating the time of death from the time of operation, the average time was the second day, the third day at the Barnes Hospital, and the thirty-sixth hour at the Children's Hospital.

The bacteria grown from the peritoneum either at the time of operation or at the time of necropsy were *Bacillus coli*, seven patients, streptococci, four, and *Bacillus acidilactici*, one patient. Streptococci and *Bacillus coli* were cultured in symbiosis from three patients, once with *Bacillus proteus vulgaris*, and once with diphtheroids. Aerobic cultures were the rule, and anaerobic cultures were made only once.

General peritonitis was usually sufficient of itself to cause death and subsidiary complications were found infrequently. Adynamic ileus, of course was always present to some degree. Otherwise only seven of the twenty-one patients were known to have subsidiary complications. Of these seven, six had pulmonary complications, in the form of bronchopneumonia, pleurisy, atelectasis of the lung, or bronchitis. One patient, W D (B H No 34464, 1932), developed a septicæmia before death, *Bacillus coli* was cultured from the blood, *Bacillus coli* and a streptococcus were cultured from the peritoneal cavity. Myocardial insufficiency hastened the death of J J W (B H No 28950, 1931), a man of sixty-two years. Two patients who died without operation showed interesting complications. The one, G A D M (B H No 28847, 1932), a man of sixty-two years, who died in uræmia on the sixth day of the disease, was found at necropsy to have acute generalized peritonitis and a greatly inflamed unruptured appendix, in addition to a thrombosis of the abdominal aorta, arteriosclerosis, chronic interstitial nephritis, bronchopneumonia, and fibrinous pleurisy. The other, R B (B H No 36601, 1932), was a man of thirty-two years who died, also in uræmia, on the seventh day of the disease. At necropsy a generalized peritonitis and a ruptured appendix were found, besides thrombosis of the mesenteric veins, multiple liver abscesses, abscess of the left lung, bronchopneumonia, cholæmia, and acute nephritis.

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One death that of L McC (B H No 5944 1918) a negress of sixty-five years occurred following an iridectomy for glaucoma Twelve days after the iridectomy having been in the hospital meanwhile she developed an acute appendicitis At operation thirty-six hours after onset the appendix was found ruptured and a general peritonitis present The patient died six days later

Only seven necropsies were obtained in the twenty-one deaths of this category Certain complications may therefore have been overlooked

Deaths Due to Abscess of the Peritoneum—By the term abscess of the peritoneum is meant a localized abscess or infection anywhere within the peritoneal cavity Every patient dying from this cause either had an abscess about the appendix region at the time of operation or developed an abscess in that location post-operatively Many patients also had abscesses elsewhere, subdiaphragmatic, *etc* as indicated below About one-fourth of all the deaths of the series were attributed to abscess of the peritoneum Ten of the thirty deaths at the Children's Hospital were due to this cause and six of the thirty-two deaths at the Barnes Hospital Abscess of the peritoneum was therefore similar to general peritonitis in that it seemed more fatal among children than among adults Thirteen of the deaths occurred among class-five patients three in class six and one in class four Patients succumbed to abscess of the peritoneum on the average twenty days after onset of the first symptom of appendicitis Children succumbed sooner ten days on the average than adults (Barnes Hospital) twenty days The earliest fatality from this cause occurred three days after onset of the appendicitis, several fatalities did not occur until a month or more after onset The average time of death was ten days after operation being four days at the Children's Hospital and thirteen days at the Barnes Pus from the peritoneal abscess of six patients yielded *Bacillus coli* The remaining cultures when taken were sterile

Complications were abundant Intestinal obstruction was the most frequent Adynamic ileus occurred in many patients Dynamic ileus (mechanical intestinal obstruction) was present in five of the sixteen three also having fecal fistulæ Bronchopneumonia contributed to the death of six patients, associated with it each in one of the six deaths, were atelectasis of the right lower lobe septic emboli of the lung lung abscesses due to a perforated subdiaphragmatic abscess F W (C H No D-1693 1927) bronchitis and fibrinous pleurisy A G K (B H No 17842 1928) also had diabetes mellitus and chronic parenchymatous nephritis Four of the sixteen patients of this category had a subphrenic abscess two had nephritis One P C J (B H No 14586 1923) had a neglected urethral stricture which had caused bilateral pyelonephritis and proved the eventual cause of death three and one-half months after appendectomy Another patient C B (C H No D-203 1927) was found at necropsy to have a perforated ulcer of the stomach associated with a communicating subdiaphragmatic and liver abscess,

this patient had had a cholecystostomy at the time of the original appendectomy

Deaths Due to Mechanical Intestinal Obstruction—Six deaths followed mechanical intestinal obstruction. Five were at the Barnes Hospital, one at the Children's. Three occurred in class-six patients, two in class five, and one in class two. Peritoneal adhesions with resulting intestinal kinks caused the obstruction in the class-five and class-six patients. These adhesions in turn were due to infection within the peritoneal cavity. The class-two patient, J H N (B H No 14762, 1928), was a "clean case", closure of the peritoneum at the time of operation was extremely difficult, and the intestinal obstruction which followed operation was found at necropsy to accompany the insinuation of a piece of omentum into the operative incision. The site of obstruction was ileum in four patients, proximal jejunum in one, and cæcum in one.

The average time of the occurrence of death was the twenty-first post-operative day, being the twenty-third day of the disease. The earliest death fell upon the sixth post-operative day, the tenth of the disease, the latest fell upon the fifty-second day after operation.

Complications consisted in spontaneous fecal fistulæ in two patients, acute parotitis in two, hypertensive cardiorenal disease in one, hypotension in one, and acute cystitis with bilateral pyelonephritis and pyo-ureter in one. Enterostomies were performed upon three of the six patients. One patient had three separate enterostomies.

The safety valve function of a fecal fistula was illustrated by J N (C H No 10536, 1916), a boy of seven years. An appendectomy was performed for an acute ruptured appendicitis with a general peritonitis. Symptoms were of thirty-eight hours' duration. A partial mechanical obstruction which developed after operation was relieved by the spontaneous establishment, on the eighth post-operative day, of a fecal fistula. The obstruction recurred immediately after the spontaneous closure of the fistula upon the seventeenth post-operative day, it was not relieved by an enterostomy performed four days later. Death occurred upon the twenty-eighth day after operation.

Deaths Due to Infection of the Operative Wound—Six deaths were attributed to the infection of the operative wound, two occurred at the Barnes Hospital, four at the Children's Hospital. One death occurred in class three, three in class four, one in class five, and one in class six. Only two deaths, therefore, followed operations where drainage would ordinarily have been established. Three of the wound infections were accompanied by gangrene of the skin and subcutaneous tissues. A gas-bacillus infection was thought to be the cause of one of these, P D G (C H No H-1945, 1931), hæmolytic streptococcus was thought to cause another, L H (C H No B-1374, 1925), and *Bacillus proteus* together with *Bacillus coli* and a hæmolytic streptococcus to cause the third, H A W (B H No 19663, 1925). Of the non-gangrenous infections, hæmolytic streptococcus caused the death of D S (B H No

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1569 1925) and of R P R (B H No 10016, 1921), *Bacillus coli* caused the death of J C (C H No 10693, 1916)

The three case histories of the gangrenous infectious areas follow

CASE I—H A W (B H No 19564 1925), a white farmer of twenty-nine years, was operated upon for an acute appendicitis of forty-eight hours' duration (class four) An unruptured gangrenous appendix was removed through a right rectus incision under open ether anaesthesia The stump of the appendix was inverted and the wound closed in layers without drainage On the sixth post-operative day 50 cubic centimetres of thick foul pus were evacuated from the wound, *Bacillus proteus* was cultured from the pus The infection spread along the subcutaneous tissues involving the skin of the lower abdomen and penis, it eventually extended to the scrotum which became gangrenous by the thirteenth day post-operative The wound culture now showed *Bacillus coli* and streptococci Despite free drainage of the infected site the patient died the next day Necropsy revealed an abscess at the appendix site extending peripherally and communicating with the abdominal wound Pyonephrosis also was found, with right and left hydro-ureter, together with bronchiectasis, bronchopneumonia, and myocarditis

CASE II—L H (C H No B-1374, 1925), a white boy of eleven years, was operated upon for appendicitis with abscess (class five), of three days' duration A ruptured appendix was removed through a right rectus incision, under nitrous oxide anaesthesia The stump of the appendix was ligated but not inverted and the abdominal wound closed quite tightly around two cigarette drains inserted about the appendix abscess Extensive gangrene of the skin of the scrotum developed on the fourth day post-operative No cultures were taken The patient died upon the seventh day after operation Necropsy revealed a pelvic abscess communicating along the spermatic cord with an abscess within the scrotum There was also a punched-out post-pyloric ulcer of the duodenum

CASE III—P D G (C H No H-1945, 1931), a negro boy of twelve years, was operated upon for an acute appendicitis with general peritonitis (class six), of three days' duration A gangrenous appendix was removed through a right rectus incision under nitrous oxide ether anaesthesia The stump of the appendix was ligated but not inverted Three cigarette drains were inserted about the site of the appendix because of the presence of a general peritonitis The wound was closed snugly about the drains Culture from the peritoneal pus was reported sterile Mechanical intestinal obstruction developed At laparotomy on the sixth day post-operatively, the site of the obstruction was found to be at the junction of the jejunum and ileum The constricting fibrinous bands were loosened with a resulting release of the obstruction The bowel wall, due to its friability, was perforated accidentally during the manipulations, releasing a thin stream of intestinal contents which soiled the wound The wound was closed in layers without drainage, and no enterostomy was performed Five days after the second operation, gas escaped from the upper angle of the wound upon cutting the sutures, and gangrene developed about the wound Multiple incisions were made into the involved areas No cultures were taken Death finally supervened upon the thirty-third day after the second operation Acute hæmorrhagic nephritis was an additional diagnosis in this case The infection was thought due to *Bacillus Welchii*

The three non-gangrenous infections were as follows (1) D S (B H No 1569, 1925) a girl of eighteen years, was operated upon for a subacute appendicitis (class three) The wound was closed in layers without drainage following the appendectomy The stump of the appendix was ligated and inverted An overwhelming wound infection developed after operation The patient succumbed on the thirty-sixth day after operation to a generalized streptococcic peritonitis with a streptococcic septicæmia, together with pyæmia

(2) R P R. (B H No 10016, 1921) a lawyer of twenty-nine years, was operated

upon for an acute unruptured appendicitis (class four) An inguinal incision was utilized because it was hoped to repair an undescended right testicle while performing the appendectomy The acutely inflamed appendix ruptured near its base during removal The stump of the appendix was secured with difficulty, and inverted after ligation The wound was drained After operation the patient developed a number of local abscesses together with a generalized streptococcic peritonitis, and a streptococcic septicæmia He died on the fourteenth post-operative day The organisms cultured at various times from various sites were hæmolytic streptococci, hæmolytic staphylococci, *Bacillus coli* and *Staphylococcus albus*

(3) J C (C H No 10693, 1916), a white boy of thirteen years, had an appendectomy for acute unruptured appendicitis (class four) The stump of the appendix was ligated and inverted The wound was closed without drainage Post-operatively intra- and extraperitoneal abscesses developed from which the patient died on the twenty-eighth day after operation No cultures were made, but the pus had a colon bacillus odor

Deaths Due to Pulmonary Embolism—Three of the deaths were attributed to pulmonary embolism All three occurred at the Baines Hospital The ages of these three patients were thirty-three, thirty-seven, and forty-three years, an age group somewhat above the average of the series One patient was pregnant One patient was in class two, one in class four, and one in class five The wounds of two patients were drained, the first not Post-operatively the deaths occurred on the fourth, the seventh, and the thirteenth day

The pregnant patient was T C S (B H No 17936, 1928), a white housewife of thirty-seven years She had had attacks of pain in the right lower quadrant of the abdomen for sixteen years She was operated upon with a diagnosis of chronic pelvic inflammation, partly because of amenorrhœa for five months The operation was performed despite the finding before operation of a thrombophlebitis of the right leg which was the result of infected varicose veins, and despite the fact that for three days pre-operatively the temperature had been 100.4°F and the pulse rate 90 beats to the minute Through a mid-line incision, the uterus was found enlarged to the size of an eight weeks' pregnancy, the adnexæ were normal, and the appendix showed "chronic inflammation" Several gall-stones were felt The appendix was removed and the wound closed without drainage On the sixth day after operation there was sudden sharp pain in the upper right chest with hæmoptysis of about 4 cubic centimetres of bright red blood Gradual improvement was noted thereafter, and the patient was allowed up on the tenth post-operative day On the thirteenth post-operative day sudden chest pain and dyspnœa developed Death occurred within eighteen minutes At necropsy multiple infarcts of the lungs were found Some of the larger branches of the pulmonary arteries were occluded as shown by microscopical examination No gross evidence of pulmonary embolism could be found The uterus contained a dead fœtus

Necropsies were not performed on the other two patients The appendix of one, incidentally, was found to contain a wire staple, the appendix itself was gangrenous and ruptured

Deaths Due to Myocardial Insufficiency—Three patients died from myocardial insufficiency They might have survived the appendicitis and the operation except for this cardiac complication All were patients of advanced age, being sixty-one, sixty-three and seventy-six years old One was

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a class-four, and two were class-five patients. The deaths occurred upon the first, second, and tenth day after operation.

One patient, J W (B H No 10684, 1921), a bookkeeper of seventy-six years, underwent operation for acute unruptured appendicitis (class four). He was at the time convalescent from a two-stage suprapubic prostatectomy performed two months previously. Three months before, his cardiac condition had been diagnosed at Barnes Hospital as complete heart-block, myocarditis, and arteriosclerosis. This patient died the day following appendectomy. Necropsy was not held.

The other two patients deserve no further mention than the fact that their blood-pressures were 155 over 90 millimetres of mercury, and 125 over 75 respectively. The latter was diagnosed chronic myocarditis pre-operatively, the former hypertension with chronic nephritis, cholelithiasis and chronic cholecystitis.

One patient, W A B (B H No 25094, 1930), a white truck driver of twenty-four years, had an appendectomy with drainage of the wound for an acute unruptured appendicitis (class four) of thirty-six hours' duration. Nitrous oxide and oxygen, with ether ventilation, were used as anaesthetics. The usual pre-operative dosage of morphine sulphate 0.01 gram and atropine sulphate 0.0004 gram hypodermically was administered. The operation consumed thirty-five minutes. Post-operatively the lungs were hyperventilated at intervals with a 30 per cent gaseous mixture of carbon dioxide. On the ninth post-operative day a small abscess of the wound was opened and drained. On the fifteenth post-operative day there were signs, both clinical and roentgenological, of lobar consolidation of the left lower lobe, the sputum was mucopurulent, and contained blood-clots. The sputum was not cultured. The pneumonia was succeeded by a left empyema, and about 100 cubic centimetres of thin, foul-smelling pus was aspirated from the left pleural cavity on the twenty-fifth post-operative day. The pus yielded a non-haemolytic staphylococcus to culture. The patient died two days later. No necropsy was performed.

The other patient, S W (B H No 8800, 1920), a negro male of sixty-five years, had an appendectomy with drainage for a ruptured appendicitis with abscess (class five). Bronchopneumonia developed after operation, and before death on the thirty-second post-operative day a diagnosis of gangrene of the lung was made. No necropsy was performed.

Death Due to Pylephlebitis—A machinist, J A (B H No 7286, 1919), fifty-four years of age, developed abdominal pain and vomiting, and had one chill before operation was performed seven days after onset. An acutely inflamed unruptured appendix (class four) was removed and the wound was closed without drainage. Death occurred the fourth day after operation. Necropsy revealed thrombosis of the portal vein, together with a liver abscess communicating with a subphrenic abscess. Cultures from the abscess yielded *Bacillus coli* and haemolytic streptococci.

Death Due to Erysipelas—A girl of eight years, LaV B (C H No G-147, 1930), was operated upon for a subacute appendicitis (class three) during an attack of facial erysipelas. Death occurred in forty-eight hours, with a wound infection and acute general streptococcic peritonitis. Blood cultures were sterile. Necropsy was not performed. The lethal infection was undoubtedly due to erysipelas.

Death Due to Measles—A boy of eleven years, F S (C H No E-906, 1928), developed measles on the tenth day of an attack of acute appendicitis. He was admitted to the Children's Hospital at that time. A vain attempt was made to allow the appendicitis to subside, and appendix abscess (class five) had developed which threatened the boy's life. Accordingly, a quick incision and drainage of the abscess were performed.

the twelfth day of the disease. Death ensued in forty-eight hours. Necropsy revealed a ruptured appendix, a subphrenic abscess, with focal necrosis of the liver. The organism cultured was *Bacillus coli*. Measles here prevented prompt surgical intervention and was considered the chief cause of the boy's death.

Death Due to Asthma—A boy of twelve years, B M (C H No A-288, 1924), had been in the hospital a year previously because of bronchial asthma and malnutrition. He was readmitted with a ruptured appendix with abscess (class five). An appendectomy with drainage was performed. Thirty-six hours later the asthma began to assert itself, there was increasing dyspnoea, the heart failed, and death followed. There was no necropsy. Asthma seemed to predominate this clinical picture.

Death Due to Leukæmia—A boy of ten years, D K (C H No G-318, 1930), had been in the hospital for some time with chronic lymphatic leukæmia. He developed abdominal signs and died without being operated upon. Necropsy revealed, besides the leukæmic picture, a perforation of the appendix walled off by adhesions as though the pus had been absorbed from the site (class five). One of the hypertrophied lymphoid follicles of the appendix was thought to have increased in size and thereby caused the infiltrated friable organ to perforate.

The Relation of Appendicitis to the Deaths of the Series—The foregoing discussion relative to the causes of death may have obscured the relationship between appendicitis and the deaths of the series. Certain deaths were due unquestionably to appendicitis as the basic cause. Others were due only in part to appendicitis. A few followed extraneous diseases or post-operative complications, or were attributable directly to the operation for appendicitis.

Appendicitis was wholly responsible for forty-three of the sixty-two deaths of the series. Under the heading of "general peritonitis" were twenty-one of these cases (p 56). There was no doubt that acute appendicitis, usually ruptured, had initiated the general peritonitis in each of these patients. These deaths from general peritonitis were therefore ultimately attributable to acute appendicitis. Under the heading of "abscess of the peritoneum" were sixteen more cases (p 57). Here again there could be no doubt but that appendicitis was the prime cause of death. Under the heading of "mechanical intestinal obstruction" were five more cases (p 58). These were the class-five or class-six cases with obstruction resulting from peritoneal adhesions following peritonitis. For these deaths appendicitis was also primarily responsible. The only death from obstruction not included here was that of J H N, because the obstruction was due to inadequate closure of the operative wound. Under the heading "pyelephlebitis" was the one remaining case due solely to appendicitis (p 61). Here the infection of the mesenteric and portal veins, which caused death, had originated from an appendix acutely inflamed.

Appendicitis was partly responsible for eleven of the sixty-two deaths. Into these deaths other factors also entered. Three of the deaths were listed under "infection of the operative wound" (p 58). These were the three gangrenous wound infections following appendectomies performed for acute appendicitis. Death here was due to the spread of infection from the acute appendicitis through tissue planes opened by the operative incisions. Three more deaths were listed under "myocardial insufficiency" (p 60). Whereas

these three patients were already debilitated by weak hearts at the time of operation, yet all had badly inflamed appendices. Blame for death here was therefore to be divided between the two lesions. Two of the deaths were listed under "pneumonia" (p 61). Both of these patients also had acutely inflamed appendices at operation. Although pneumonia and its complications eventually proved fatal to both, yet it is probable that appendicitis contributed to the beginnings of the pneumonia. Thus W A B yielded a staphylococcus both by culture of the peritoneal cavity at operation and of the post-pneumonic empyema thoracis immediately prior to death. One of the deaths was listed under "pulmonary embolism" (p 61). This patient had a ruptured appendix with abscess. Here infection in the pelvis may have been partly responsible for the formation of the thrombus which gave rise to the lethal embolus. The death listed under "measles" (p 61) resulted both from the appendiceal abscess and from measles. Likewise the death listed under "asthma" (p 62) was due both to asthma and to appendicitis.

Appendicitis was probably not to be blamed for the eight remaining deaths. Defects in technical operative procedures accounted for four of these deaths. Operative complications caused two others. Extraneous diseases produced the other two.

Deaths attributable to operative technic included three of the "infections of the operative wound," and one of the "mechanical intestinal obstructions." The three former followed contamination of otherwise clean operative wounds with pathogenic microorganisms at the time of operation. The latter death, that of J H N, seemed due, in part at least, to the inclusion of a portion of omentum within the operative wound. This patient, who had a recurrent appendicitis, died from mechanical intestinal obstruction.

Deaths attributable to operative complications included two of the deaths from "pulmonary embolism" (p 60). One of these, that of H L S, was unavoidable. The other, that of T C S, a pregnant woman with thrombophlebitis of varicose veins of the lower extremity and only a recurrent appendicitis, represented an operative procedure that might have been postponed till a more favorable time.

Deaths attributable to extraneous diseases included the death from "erysipelas" (p 61), and that from "leukæmia" (p 62). In the former, operation might well have been postponed, death was due solely to the sequelæ of surgical erysipelas. The latter death was inevitable, it occurred in the absence of operation. Operation would not have prevented death from leukæmia, although operation might have prolonged life.

The Relation of Death to Operation—Those deaths which occurred within twenty-four hours of operation were investigated to determine the relationship between operation and death.

Eight such deaths were found. Seven occurred at the Children's Hospital, one at the Baines. Seven of the patients had a ruptured appendicitis with general peritonitis (class six). One had a ruptured appendix with abscess (class five). All eight patients were very sick at the time of opera-

tion All had peritonitis either local or general Seven were children, three being three years of age or younger Hence the outlook at the time of operation was very grave in each instance Had operation been withheld, there was little doubt but that every patient would have died Operation merely hastened the time of death, while affording the only chance of recovery to the patients

Operation undoubtedly precipitated some of the deaths Thus J W (C H No 1 1615, 1932), a boy of five years, was admitted with a general peritonitis (class s1\). Symptoms were of two days' duration The temperature was 41° C, the pulse rate 150 beats per minute, and the respiratory rate 42 The blood-pressure was so low that it could not be measured Subcutaneous physiological saline solution was administered before operation Appendectomy was performed under drop ether anæsthesia, and the wound drained There was free pus in the peritoneal cavity The operation occupied ten minutes The child died one hour after operation

Operation was often delayed for the purpose of improving the condition of the patient Thus M J (B H No 22736, 1929), a negro Pullman porter of thirty years, continued to work until admission seventy-two hours after onset of an acute attack of appendicitis He had general peritonitis (class s1\.) on admission He had taken salts and enemata on several occasions during the attack In view of the improvement shown following the subcutaneous administration of a litre and a half of physiological saline solution, operation was postponed twenty-four hours Appendectomy with drainage was then performed under nitrous oxide-oxygen anæsthesia with ether ventilation The operation occupied forty minutes The patient died seven hours later

Operation was not responsible for one of the deaths This was due mainly to a glucose reaction D H (C H No I-1456, 1932), a girl of eleven years, was admitted upon the seventh day of an appendicitis with generalized peritonitis (class s1\.) The temperature upon admission to the hospital was 40.4° C, and the pulse rate 130 beats to the minute A 10 per cent solution of glucose administered intravenously before operation was followed by a chill and by elevation of the temperature to 42° This reaction was attributed to the glucose Operation performed with the patient in the midst of the glucose reaction was followed two hours later by death The deaths occurred from forty minutes to ten hours after operation

It was concluded that operation, or procedures associated with operation, hastened the deaths of eight of the sixty-two patients of the series It also seemed probable that death would have occurred in each instance had operation been withheld

The deaths which occurred as late results of operation have already been discussed

The Prevention of Deaths from Appendicitis—The mortality from appendicitis may be drastically reduced That this is more than theoretically possible is indicated by the decrease in the recent mortality of the disease compared to its mortality several decades ago in certain institutions such as the Union Memorial Hospital in Baltimore² and the Boston City Hospital⁴ The intelligent application of well-proven principles of treatment, together with accurate diagnosis, must inevitably be rewarded by a steady diminution both in the number and in the percentage of deaths from appendicitis

Before this can be accomplished it is necessary that there be a widespread diffusion of elementary knowledge of the disease and of its severity It is

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particularly important that every physician be familiar not only with the signs and symptoms of appendicitis but also with the main reasons for the death of the majority of individuals with appendicitis. Such simple principles should also be appreciated by the body of the laity, and especially by the druggists to whom so many persons will at first apply for the relief of the initial pain of the disease.

Many of the facts upon which the prevention of death from appendicitis is to be based have been discussed above, others will be presented below. None is new, none but needs renewed notice.

In the first place patients in certain categories are more liable to die from appendicitis than others. These classes of individuals obviously need especial care both in regard to diagnosis and to treatment. Thus children run greater risks from the consequences of appendicitis than do adults (p 48). The younger the child the greater the risk (p 49). Adults of advanced years are even more prone to die from appendicitis than younger children, and therefore demand a proportionate degree of alert handling. The same is true of males. Men must be more seriously regarded than women (p 49), unless the woman be pregnant (p 50). Negroes seem to die from appendicitis more readily than whites (p 50).

In the next place attention should be directed towards reducing the high mortality which accompanies peritonitis (pp 51-56). The best way to do this is to prevent the occurrence of peritonitis. By operating upon the acutely inflamed appendix before peritonitis has become established one might hope to reduce the mortality figure from 77 per cent, representing the combined mortality for classes four, five and six to slightly over 2 per cent, the mortality figure for the acute unruptured appendicitis group alone (p 51). By so operating upon a series comparable in number to this one twenty deaths might be expected in place of sixty-two.

Early operation then is to be stressed. If operation be performed within forty hours of onset of appendicitis there is reasonable hope that the appendix will not have ruptured (p 52). Every hour of delay in operating during the first three days of the disease increases the expected mortality many times as Tables V and VI graphically illustrate. The mortality of acute appendicitis about doubles itself every twelve hours of the first two days. Even though a general peritonitis be already established operation during the first twenty-four hours of the disease is accompanied by little risk judged by this series.

Surgical removal of the appendix in the interval between attacks is to be strongly recommended. The mortality of this procedure here was six-tenths of 1 per cent (p 51). Moreover twelve of the sixty-two patients who died gave histories of previous attacks of appendicitis. These twelve lives would have been saved had the patients' physicians insisted upon an interval appendectomy.

It is needless to observe that simple drainage of an appendix abscess should always be followed at a later date by appendectomy. Failure to follow this procedure resulted in the death of C. C. (B. H. No. 17342, 1924). Twenty

years previous to admission this patient had had simple drainage of an appendiceal abscess. Upon admission, an appendiceal abscess (class five) was again present, eventually causing the death of the patient despite operation.

Appendectomies, where feasible, should be performed in the course of other intra-abdominal operations. Omission of this procedure during hysterectomy eighteen years before admission to Baines Hospital resulted in the death of Z O (B H No 32143, 1931), from an appendiceal abscess (class five).

Women who have had appendicitis and are contemplating marriage should be strongly urged to part with their appendices lest a flareup of appendicitis coincide with a future pregnancy. Should appendicitis develop during pregnancy an operation should be performed at the earliest possible moment. It is well known that the mortality from acute appendicitis with peritonitis is very high during pregnancy.⁵ This series indicates the relative safety of operating for an unruptured appendicitis during pregnancy.

The part played by laxatives in the increase in the mortality of appendicitis should be so well known as to demand little mention. In this series the mortality from acute appendicitis among patients who had been given a laxative was at least seven times as great as among those who had received no laxative. It cannot be too strongly urged that abdominal pain should always be treated by qualified individuals. Yet how are druggists and laymen to be blamed for administering laxatives to patients with abdominal pain when occasional physicians persist in giving laxatives to persons with acute appendicitis?

Comment—The mortality rate of this series of cases is about the same as that of some recent series. The present operative mortality rate was 2.43 per cent of 1,859 cases. That of Finney, Jr.² was 2.33 per cent of 3,913 cases. That of Osler⁶ was 3.20 per cent of 1,000 cases. In Finland, Hjelmman⁷ reports a mortality rate of 2.42 per cent for 5,287 cases.

The mortality rate for acute cases treated operatively here, *i e*, classes three, four, five and six, was 5.0 per cent of 1,099 cases. The mortality rate for a similar group at the Boston City Hospital from 1927 to 1930 was reported by Walker⁴ to be 5.8 per cent of 2,106 cases. Walker also calculated the mortality rate of 33,008 acute cases reported by various authors from 1923 to 1932 to be 5.3 per cent. In Great Britain, Colt and Morrison⁸ report a mortality rate of 2.84 per cent for 1,413 acute cases.

Turning, for a moment, to the era before the time of Reginald Fitz,⁹ we find Bull¹⁰ proud to report a mortality rate of 47.8 per cent for sixty-seven non-operative cases.

The mortality rates by classes reported by Finney, Jr., Hjelmman, and the present paper are similar, although Hjelmman's figures for cases with peritonitis are lower. Authors generally agree that the male mortality rate exceeds the female. The high mortality rate among the aged and among children are likewise well known. During pregnancy, Marbuys⁵ cites a maternal mortality rate of 26.4 per cent and a foetal mortality rate of 47.0 per

DEATH FROM APPENDICITIS

cent from a review of 364 cases from the literature Royston and Fisher¹ report two deaths among ten patients of their own Osler⁶ notes one death out of fifty non-perforative cases There was one death out of seventeen non-ruptured cases here

Bower¹¹ has done extensive work from a public health view He points with pride to the low mortality rate from appendicitis in Philadelphia in 1930, and attributes it in large measure to public education His views are significant and seem worthy of widespread application They coincide with those expressed here under the heading of prevention of deaths from appendicitis

Summary and Conclusion —(1) The mortality rate, operative and non-operative, of a series of 1,859 cases was 3.33 per cent

(2) The operative mortality rate was 2.43 per cent

(3) The mortality rate for acute appendicitis was 5 per cent

(4) The mortality rate was about four times as great at the St. Louis Children's Hospital as at the Barnes Hospital The figures were 7.89 per cent and 2.16 respectively

(5) The mortality rate was highest during the seventh and eighth decades of years It was next highest during the first five years of life It was lowest during the third decade of years

(6) The mortality rate among males was about three times as great as among females

(7) The mortality rate during pregnancy was 5.88 per cent No cases of peritonitis during pregnancy occurred, however

(8) The negro mortality rate was about twice that of the whites

(9) The mortality rate from chronic and subacute appendicitis was virtually nil

(10) The mortality rate from acute unruptured appendicitis was slightly over 2 per cent

(11) The mortality from ruptured appendicitis with abscess or with localized peritonitis was 7.3 per cent

(12) The mortality from appendicitis with general peritonitis was nearly 28 per cent

(13) Appendicitis, not operation, was the major cause of the mortality from appendicitis

(14) Delay in operating increased the mortality

(15) The administration of laxatives to patients with appendicitis greatly increased the mortality

(16) The chief cause of death from appendicitis was peritonitis Thirty-seven of the sixty-two deaths were so caused

(17) The causes of death were discussed

(18) The rôle of operation in the causation of death was considered

(19) Means for preventing death from appendicitis were demonstrated

(20) Deaths from appendicitis can be prevented by (a) Accurate diagnosis (b) Very prompt operation within the first forty-eight hours of the

disease (c) Adequate operation properly timed for patients seen late with peritonitis Proper pre-operative treatment (d) Absolute avoidance of laxatives for patients with appendicitis (e) Interval appendectomies for patients who give histories of one or more definite attacks (f) Appendectomies, where feasible, during the course of other intra-abdominal operations

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CANCER OF THE MOUTH

BY CARL EGGERS, M D

OF NEW YORK, N Y

By TUMORS of the mouth one usually means new growths arising from the soft parts. They include the lip, the tongue and the mucous membrane of the cheeks, the palate, the gums, and the floor of the mouth. Tumors of the jaw bones, and those of the tonsils and salivary glands are not included, though these structures are frequently involved secondarily by direct extension of the primary growth.

Owing to the careful histological studies which have been made of late years, and to the observations made on the reaction of tumor-cells to radium and the Rontgen-ray, much new knowledge has been added to the subject.

Most cancers of the mouth arise from the lining pavement epithelium of the buccal cavity, but there are some tumors which do not correspond to this common type. I shall mention them briefly.

(1) Sarcoma is very rare. It is occasionally found in the tongue, or at times constituting a malignant epulis.

(2) Lymphosarcoma is found more often in the pharynx and nasopharynx than in the mouth proper.

(3) Carcinoma of cylindrical-cell origin is occasionally found in the floor of the mouth. It is probably derived from salivary-gland tissue.

(4) During the last few years certain tumors have attracted considerable attention, which, on account of their histology, have been variously named transitional-cell epidermoid carcinoma, branchiogenic carcinoma, or endothelioma. They show no flat pavement characters, no spines, no hornification, and no pearls. They are very radio-sensitive. They are supposed to arise from nests of transitional epithelium in the nose, the crypts of the tonsil, the base of the tongue, and sinuses of the larynx. It is believed that at times they may originate from squamous cells which lose their epithelial characters and assume anaplastic features. The structural characteristics of these tumors are maintained in the metastatic cervical lymph-nodes and in distant visceral metastasis. Ewing, Quick, New, and Broders have given us excellent descriptions of the pathological and clinical features of these tumors as well as of their reaction to radiation. Because they are usually found in organs not included in the scope of this paper they will not be considered in detail.

(5) There is another mouth tumor to be mentioned briefly, and that is epulis, which is classed¹ as semi-malignant. Its etiology is not known, it is most common between twenty and forty years of age, and it is two or three times more common in women than in men. At times its structure may be that of a fibroma, while at other times it has the appearance of a sarcoma, usually the giant-cell type. It may be histologically benign but clinically

malignant It presents itself as a somewhat pedunculated growth with a narrow pedicle which projects between the teeth, arising from the periosteum of the alveolar margin, or from the periodontium It is usually dark bluish-red in color and covered with mucous membrane, but it may perforate and bleed easily The tooth, or teeth, of the affected sockets may loosen, and gradually a destructive suppurative process may develop It is prone to recur after incomplete removal For this reason it is important to remove the tumor together with the affected tooth, or teeth, as well as with the periosteum and that portion of bone from which it arises

Typical mouth carcinoma is a cancerous growth arising from the pavement epithelium It is called epithelioma, epidermoid carcinoma, or acanthoma It is fairly common and forms approximately 3 per cent of the total mortality from cancer A point of great interest is the relative frequency in men as compared with women Figures vary, of course, but in a general way it seems that among 1,000 women with cancer, there are only about 12 to 13 with cancer of the lip, tongue and mouth, while among 1,000 men with cancer, there are about 110 to 115 with an affection of the same organs, of which about seventy-seven affect the lip, twenty-one the tongue, and fourteen the rest of the mucous membrane



FIG 1—Typical small epithelioma of lip

Among 1,000 cancers of the tongue, almost 85 per cent are found in men, and only 15 per cent in women

The death rate is highest in cancer of the tongue and lowest in cancer of the lip

In New York City the deaths from all forms of cancer are gradually increasing, having gone up during the last six years from 7,033 in 1926 to 8,336 in 1931 This may be partly accounted for by increase in population During the year 1931 there were 224 deaths in New York City from cancer of the mouth, of which eighteen affected the lip, 116 the tongue, and ninety other parts of the buccal cavity

Cancer in any part of the body fills the patient with dread, and when it affects the structures of the mouth this dread is increased because of the associated unpleasant symptoms His inability to properly masticate and swallow food, the difficulty with speech, the dribbling of saliva, and possibly associated pain, disagreeable odor, and disfigurement make him introspective and shun society For these reasons the entire subject of intra-oral cancer is one of primary importance, and if one adds to that the high mortality, especially of tongue cancer, it becomes evident that early correct diagnosis and treatment along the most modern lines are essential

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Etiology—In searching for the causes of mouth cancer, various interesting facts become evident, which suggest etiological relationship. The first is the great frequency in men as compared with women, about eight or ten, to one. The second is that most patients affected are heavy smokers. The third is that many patients have a syphilitic history or a positive Wassermann. The fourth is the common history of a benign pre-existing lesion on the lip or in the mouth. The fifth is the frequent association with leukoplakia, especially in cancer of the tongue. The sixth is the common finding of associated mouth irritation or infection.

In no other group of cancers is there such a wealth of apparent evidence of the association of irritation and infection with the development of malignancy.

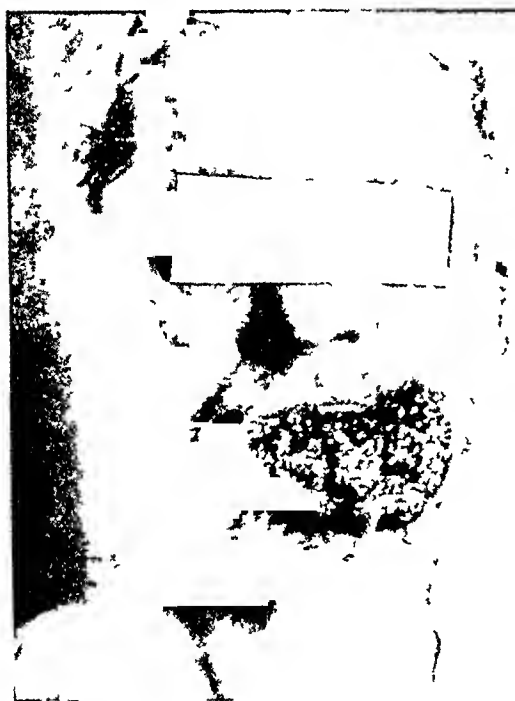


FIG 2—Large papillary epithelioma of lip of two years' duration



FIG 3—Same patient as Fig 2. Excision of lesion with plastic reconstruction of lip and chin

nant change. To my mind, the greatest interest in mouth cancers lies in this particular phase of the subject, because if that relationship is established it becomes evident that it is within our power to prevent the development in a certain percentage of cases.

As with cancer in other parts of the body, we assume a certain predisposition to its development. Such predisposition may be hereditary, and it is therefore particularly important for susceptible individuals to avoid influences which are supposed to stimulate abnormal cell growth.

When we come to more definitely define the etiology, we meet great difficulty, but we may assume the presence of certain degenerative cell changes in the mucous membrane of old individuals in whom cancer is most common. As a matter of fact, some such cell changes are grossly visible in scaling and keratosis of the lips, and in changes that are associated with leukoplakia. Microscopically, atrophic and degenerative changes are frequently encountered.

Given, then, a patient with a certain susceptibility to the development of cancer, and with senile degenerative cell changes of the mucous membrane, one or the other of the above-mentioned factors which act as chronic irritants may gradually bring about malignant change in the cells.

The greater frequency of mouth cancers in men as compared with women is supposed to be due to the more liberal use of alcohol and tobacco and to neglect of mouth hygiene. Just how tobacco acts is not known, it is even questionable whether it is the tobacco itself, or whether certain products of combustion liberated by smoking are the cause, or whether the heat of a pipe stem or actual burning produce the first cell changes which lead to malignancy. The fact remains that nearly all writers report a large percentage of heavy smokers among their patients with malignant mouth lesions. In the same way, the rôle alcohol plays cannot be definitely stated, nor whether it acts as a local irritant, or as a circulatory toxin after it has been absorbed.

The relatively greater frequency of decayed teeth, pyorrhœa, and other mouth infections in men has been held to at least partially account for the predominance of mouth cancers in them. Epithelioma of the lips is eight or ten times as common in men as in women, and particularly in men leading an outdoor life, such as farmers, truckmen, and sailors. It is supposed to be exposure to wind and sun, perhaps associated with excessive smoking, which is the cause of the cell changes. Fever blisters and cold sores, cracked lips, dry scaly conditions of the lips, or actual keratosis, biting of the lips or burning them frequently precedes the development of the malignant ulcer. At times a simple ulcer is found in the mouth opposite a sharp corner of a tooth, or at a place where pressure is exerted by a badly fitting plate. Removal of the irritant usually brings about prompt healing. At other times a chronic ulcer, one which has become malignant, is found in similar locations under similar conditions, indicating that it was the chronic irritation which brought about the change.

The relation of syphilis to the development of cancer of the mouth is an interesting one. Some authors report a large percentage of syphilitics among their patients and believe that there is a definite direct etiological relationship between the two diseases. Others again feel that the co-existence of the two has no special significance. It is easily conceivable that the presence of an old syphilitic glossitis acts as a constant irritant and that it alone, or in combination with smoking, will lead to the development of cancer. A history of syphilis or a positive Wassermann reaction in a patient with an ulcer of the tongue or mouth suspected of being malignant, call for the exercise of great care.

The association of carcinoma, especially of the tongue, with leukoplakia is of more than passing interest and deserves careful attention. Some authors report more than half their tongue cancers as having developed on the basis of leukoplakia, others assign to it a numerically less, but always important rôle. My own belief is that a large number of patients with leukoplakia eventually develop carcinoma unless they resort to the prophylactic care

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indicated in their case. The condition is so important that it is worth while to study it and to review what we know of its etiology and its behavior.

Almost everything that can be said about the etiology of cancer of the mouth applies in a similar manner to leukoplakia. It is most common after middle age and affects the male sex almost exclusively. Its appearance in old syphilitics is frequently stressed though no direct relationship can be established. Moreover, it does not yield to antispecific treatment. The common old name of "smokers' patches" suggests the use of tobacco as an etiological factor, and that belief is still held. As a matter of fact, smoking, especially in old syphilitics, seems to be the most common cause. In the same way refraining from smoking brings relief of symptoms and may stop



FIG 4—Recurrent epithelioma of lip. One year after treatment with radium.



FIG 5—Same patient as Fig. 4. Excision of lesion with bilateral bloc dissection of the neck in one sitting. Three days after operation.

extension of the process. Other etiological factors are supposed to be alcohol, mouth infections, gastro-intestinal disturbances, and highly seasoned or hot foods.

Clinically, leukoplakia is an idiopathic, slowly developing disease, which is most common on the dorsum and the borders of the tongue as well as on the gums and cheeks. The first symptoms are usually slight, and consist of burning, especially when smoking or on contact with highly spiced or hot food. Gradually pain develops and the tongue may feel stiff, making speaking, chewing, and swallowing difficult.

The appearance of the lesion depends on the stage of development. In the beginning, there are superficial white spots, which may be large or small.

they are frequently multiple and irregular in shape. Later they become elevated and more hornified and thick and finally fissures and ulceration develop on them. Even slight trauma may produce bleeding. During this stage of thickened epithelial plaques there is œdema and infiltration with leucocytes in the subepithelial layer and mitosis is active in the depth. Then begins atypical epithelial penetration and the change from a benign to a malignant lesion is on the way.

The treatment of leukoplakia should be conservative in the beginning. It is important to remove all sources of irritation, such as pyorrhœa and infected roots. The patient should avoid hot and strongly spiced foods. Smoking must be absolutely stopped. Intestinal disorders and constipation should receive the necessary attention. Locally, the use of a bland mouth wash should be encouraged, and the use of all caustics strongly discouraged. Anti-syphilitic treatment has no effect on the lesion. Treatment with Röntgen-rays and radium has been disappointing. The treatment of the early lesion then resolves itself into the conservative measures mentioned above. By adhering strictly to this routine, leukoplakia may exist for years without producing serious symptoms. In case the lesion shows a tendency to get worse, as indicated by thickening, fissure formation and ulceration, it should be excised with a cautery and a careful examination made for possible malignant change.

Summing up the various points relating to the etiology of cancer of the mouth itself, as well as of the so-called pre-cancerous lesions, it appears that trauma in the form of chronic irritation or inflammation plays a more direct rôle than can be demonstrated in cancers of most other parts of the body. It is probable that no one factor alone is responsible, but rather a combination of two or more, such as infection and smoking, or syphilis and smoking. It is important never to lose sight of this fact, as by a proper appreciation of this relationship it may be possible to discover and treat the lesions during their pre-cancerous stage.

Spread of Carcinoma—Experience has shown that cancer of the buccal mucosa is usually a rapidly growing form of carcinoma, which is often incurable a few months after the onset of the disease. This is due to the fact that it remains localized for only a short while, and shows great tendency to spread. This extension of malignant cells from the primary growth is an insidious one and may occur in several ways.

(1) There is usually a local invasion of the surrounding tissue by direct extension. Depending on whether this tissue is soft and vascular, or whether it is muscular, or whether connective tissue offers resistance, the growth may be rapid or slow, confined to the immediate surroundings of the primary tumor or deeply infiltrating.

(2) A second mode of extension is along fascial planes.

(3) At times cancer-cells are spread by the blood-stream. Not infrequently a tumor embolus is found in a blood-vessel in which the cells may

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grow and eventually completely occlude it, or some of the cells may break off and be carried to distant parts of the body, or to the lymph-nodes

(4) Not infrequently, malignant cells in their spread through the surrounding tissue of the primary growth encounter nerve fibres which they may surround or infiltrate. This mode of extension is held responsible for the severe neuralgic pain of which patients with mouth lesions so often complain.

(5) The most familiar extension is that along the lymphatic channels to the lymph-nodes draining that area. This produces enlargement of the nodes, which after a while becomes clinically recognizable. Metastatic carcinoma secondary to mouth tumors is usually limited to the neck, but the extension is not always to the nearest related lymph-nodes. It may be by direct paths to the supraclavicular nodes, or by paths crossing the median line to the lymph-nodes of the op-



FIG 6—Typical carcinoma of the tongue along outer border

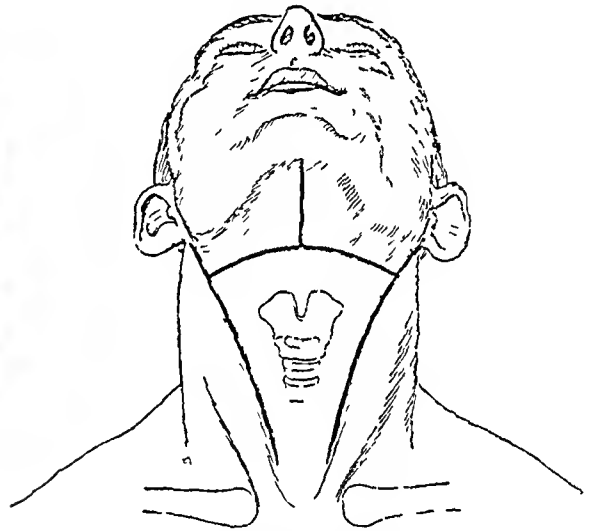


FIG 7—Incisions used for bilateral bloc dissection of neck

posite side. The importance of such neck metastasis cannot be overestimated, for experience has shown that if a cancer has invaded the neck, the outlook for permanent cure is poor.

Symptoms—In the early stages there are frequently no symptoms except the appearance of the local lesion, which the patient can either see or feel. It is due to the absence of associated symptoms that patients so often neglect to ask for medical advice at an early date. In case the ulcer is grafted onto a pre-existing lesion which produced symptoms of burning or pain, a change in these symptoms may attract his attention. There is frequently local pain when hot or spiced food comes in contact with the lesion, or while smoking. Later such local pain may be constantly present and may interfere with speech, mastication and deglutition. As the disease progresses and invades the surrounding tissue there may be referred pain, and on account

of the breaking down of the tumor there may be foul malodorous discharge and dribbling of saliva. One of the reasons for the lack of symptoms is that these lesions are frequently found in men who are not very sensitive to the development of a growth. They have allowed themselves to harbor pyorrhœa, decayed teeth, and their mucous membrane may be insensitive because of excessive use of alcohol and tobacco.

Diagnosis and Differential Diagnosis—There should usually be no difficulty about the diagnosis. The lesion can be seen and felt and has certain characteristics which should classify it. In most instances of a malignant tumor of the buccal mucosa we are dealing with a hard indurated ulcer, at times the growth is more papillary in character, and sometimes it arises in the depth as a hard nodular growth which secondarily involves the mucosa.

Early diagnosis is most important, therefore every effort must be made to rule out conditions which may simulate it. The most common and important differential diagnosis is from syphilis, then follow simple ulcers from pressure of teeth or plates, tuberculosis, ulcerating sarcoma, ulcerating angioma, and actinomycosis.

Usually a correct diagnosis can be made clinically if one has had some experience with these lesions. Nevertheless, there may be great difficulty at times to differentiate between a carcinoma and a late luetic lesion, either a gumma or a sclerosing glossitis. Especially is this true if there is a positive history of syphilis or a positive Wassermann reaction. Important differential points are that carcinoma is usually a single lesion and in the case of the tongue it is nearly always situated at the border, rather far back, opposite the molars. Gummata on the other hand are often multiple and they, as well as syphilitic glossitis, choose the tip of the tongue and the posterior part of the dorsum as their seat. Carcinoma is often painful, bleeds easily and produces enlargement of lymph-nodes, while a gumma is usually not painful, does not bleed easily, and rarely produces lymph-node enlargement. The presence of areas of leukoplakia speaks for the diagnosis of carcinoma. The important thing is not to be misled by a positive Wassermann reaction. It is wise to consider every ulcerative lesion of the mouth cancerous until proven otherwise. Never should one continue antispecific treatment for a long time just because of a positive Wassermann. Too much harm has been done that way and many patients have been allowed to go from an operable to an inoperable stage before the mistake was discovered. If all other means at our command fail to make a correct diagnosis, a biopsy is urgently indicated.

Treatment—In contemplating the treatment of any malignant tumor of the mouth we have to consider not only the primary lesion but also the entire lymphatic drainage field which may become invaded by the growth. Long ago it was recognized that removal or destruction of the mouth lesion alone was unsatisfactory, and that it was necessary to also take away the involved lymph-nodes of the neck. Later, the surgeons went a step further and removed the lymphatics before they became involved, or at any rate

before there was any evidence that they had been invaded. It was recognized that the best results were obtained if one followed the principle "Small cancers, extensive operations."

Most surgeons still adhere to this principle as well as to the practice of removing the local lesion together with the lymphatic drainage area. The operation is usually divided in such a way that removal of the lymphatics precedes or follows the excision or destruction of the local lesion. There are, of course, variations from this procedure. One may be dealing with primary tumors so early that excision of the local lesion alone is considered sufficient, especially if examination of the growth has shown a low-grade malignancy. Then again the general condition of the patient may not warrant an extensive neck dissection.

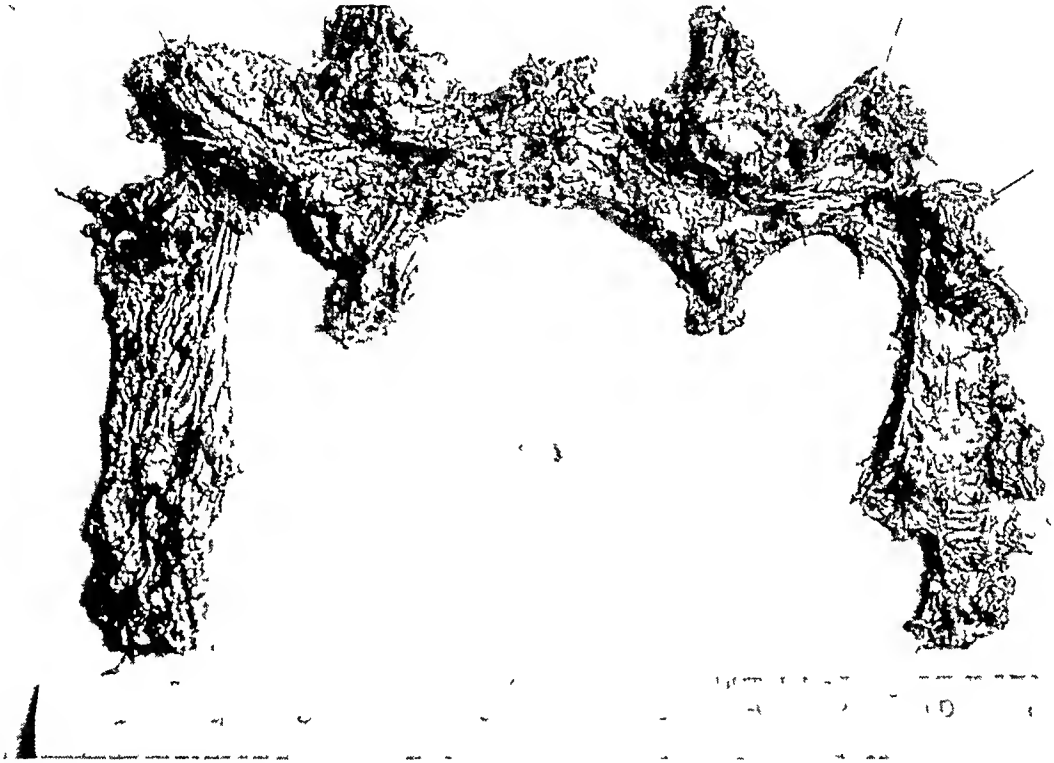


FIG 8—Complete specimen bilateral bloc dissection of lymphatic structures of neck.

Since the introduction of radium and Rontgen-rays in the treatment of malignant growths, and recognition of the value of radium, particularly in lesions of the skin, mouth, and uterus, there has been a great change in treatment. Many of the larger clinics, which have a sufficient supply of radium available, have discontinued surgery within the mouth almost entirely and substituted radium therefor. It is used in the form of external application or interstitial implantation, depending on the location and type of the lesion, on the quantity of radium available, and on the experience of the individual operator. In some of these clinics no routine neck dissection is practiced. In general, the following procedure is followed. In all those cases in which there is no gross involvement of the lymph-nodes, the neck areas are treated with external radiation by means of Rontgen-rays or radium packs. The idea underlying this treatment is the observation that

irradiation apparently stimulates the normal resisting power of lymph-nodes to carcinomatous invasion. No cure is expected that way because adult type epidermoid carcinoma is known to be very radio-resistant. In case the lymph-nodes are grossly involved, or subsequently become involved, they are either excised in a surgical manner by bloc dissection, or they are treated with interstitial irradiation by implantation of radium into the wound.

These, in short, are the guiding thoughts in the treatment of malignant tumors of the mouth. There are, of course, numerous variations, especially in the treatment of the primary tumors. Instead of using irradiation or excision with the knife, some surgeons practice excision with the electro-cautery knife, or destruction of the growth by electro-coagulation, the actual cautery and other methods.

In order to properly treat an individual case with cancer of the mouth, it is well to remember that the primary tumor remains localized for only a short time and that there is a great tendency for the cancer to spread in the different ways enumerated above. How should this invasion be met? It is not possible to quote all the different views. In general, however, it may be said that radiologists are guided by the thought that prophylactic radiation over the neck in the grossly uninvolved cases is sufficient. It is their view that in the great majority of cases no neck metastasis will develop if the primary tumor has been cured by radium. In case the lymph-nodes become enlarged they believe that it is still time to do a bloc dissection so long as the cancer-cells have not broken through the capsule. After they have broken through and invaded the surrounding structures, interstitial irradiation is used by implanting radium into the wound.

Surgeons, on the other hand, follow the reasoning that it is not possible to tell by external palpation whether invasion of lymph-nodes has taken place, and that small cell nests may be present very early. They are guided by the experience of years, which has shown that if a cancer has invaded the neck, the outlook for permanent cure is bad. They therefore practice routine bloc dissections of the neck in the majority of cases, before there is any clinical evidence that the lymph-nodes have become involved.

There are differences of opinion among surgeons as to the best procedure in certain types of cases, there are likewise differences of opinion among the radiologists, and there are probably more differences between the two groups. There has been, and I think still is, a certain hostility on the part of some surgeons towards radiologists. They consider the methods of treatment unsurgical and they doubt the permanent curative effect of irradiation. The excellent results published by some of our clinics in which radium and Röntgen-rays are extensively employed must convince the most sceptic that there is great merit in these procedures.

Rather than antagonize each other, it is of importance for surgeons and radiologists to combine and together attack the problems. From a study of the literature, and from personal experience, I am convinced that a suitable combination of the two methods has great advantages and holds out more

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hope to the patient than the use of either alone. Some hospitals have acted on this and have a radiologist on their staff who confers with and aids the surgeons in the treatment of these cases.

By any of the enumerated methods the primary lesion may be cured, the important thing is to individualize and to use that form of treatment which will most likely lead to a cure. Poor, incomplete surgery, and poor irradiation with an insufficient quantity of radium will do harm by favoring spread of the disease until it is inoperable. The crux of the successful treatment is to get the case early. The second important point is the treatment of the lymphatic drainage area. Is it safe to await gross metastasis, or is it better to do routine bloc dissections for the purpose of preventing a spread downward?

Personally, I believe that it is in the best interest of the patients to differ-

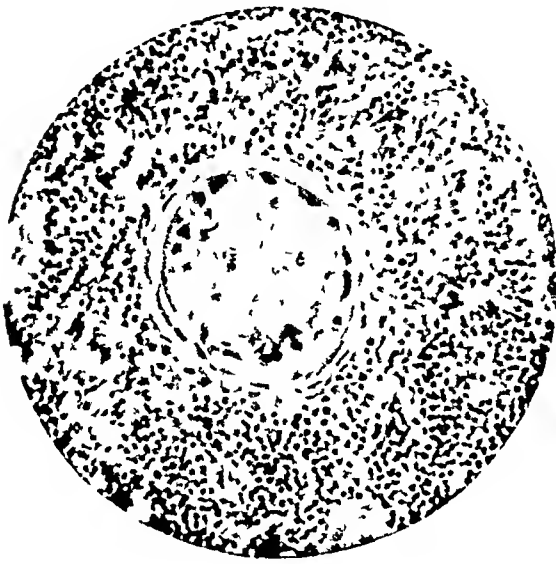


FIG 9—Tumor embolus in a blood vessel of a lymph node. It has no doubt been carried there by way of the blood stream.

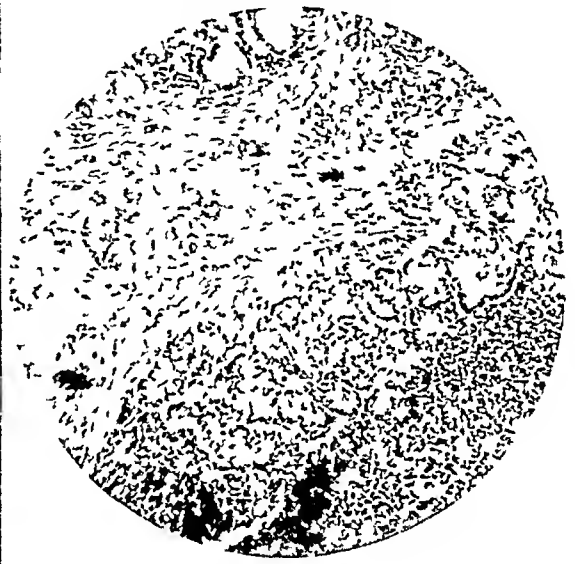


FIG 10—Tumor metastasis in the peripheral sinus of a lymph node. Such metastasis are carried to the node via the lymph channels.

entiate somewhat and not to treat all of them alike. Bearing uppermost in our mind the thought that actual invasion of the neck nodes with carcinoma very materially diminishes the patient's chances of a cure, it should be our aim to remove the lymphatic drainage area together with the primary lesion unless there are contra-indications or unless we know that the primary lesion is a very early one and low-grade malignancy.

In certain of the small, typical lip lesions, for instance, we know that lymph-node involvement of the neck usually occurs quite late. In such cases it may be perfectly safe to be satisfied with an application of radium to the lip, or with a wedge-shaped excision of the lesion, especially if there are contra-indications to a long difficult operation such as a properly performed bloc dissection of the neck. The same may apply to an early lesion of the mucous membrane of the cheek or of the mucous membrane of the palate and gums. In the more extensive lip lesions, however, wide excision of the primary tumor and bloc dissection of the neck are indicated.

In case the lesion is definitely on one side, a unilateral neck dissection is sufficient. In case it is situated in the median line, a bilateral dissection should be done. In those cases simple wedge-shaped excision of the growth is inadequate, one has to do a wide excision with some form of plastic closure according to the method of Dicffenbach, or a modification to suit the individual case.

When we come to the cancerous lesions of the tongue and the floor of the mouth, however, I believe it is best to proceed more radically. I know of no reason why our attitude in this field of surgery should be different from that relating to cancer of other organs, in all of which we aim to remove the lymphatic drainage area together with the primary lesion. As a matter of fact, there are very strong and urgent reasons why we should remove all the lymph-nodes which may possibly become involved, and these are the knowledge that nodes become involved early, and that they are fortunately accessible to the surgeon.

Whether the primary lesion in the tongue or the floor of the mouth be treated with radium, or whether it be excised with the cautery or knife or whether it be destroyed by electro-coagulation or the actual cautery, the lymph-nodes of the neck should be removed, and they should be removed on both sides because of the frequent bilateral involvement. Whether the primary lesion be treated first, with perhaps the dissection of one side of the neck, or whether the entire lymph-node extirpation be completed first, perhaps combined with ligation of the lingual arteries, will depend on the case and on the experience of the individual operator.

It is my custom to do the block dissection and ligation of the lingual artery on the affected side as the first operation. As soon as the wound has healed I do either the other side and at the same session extirpation of the mouth lesion, or I simply remove the mouth lesion with the electro-cautery knife, and defer the bloc dissection of the opposite side to a later date. At times I have done bilateral neck dissection in one sitting, but it is a severe strain on a patient, and should be done only in well-selected cases.

The important thing in the treatment of cancer of the mouth is not to overrate the value of a given therapeutic agent, but to recognize the limits of each.

EPITHELIOMA OF THE LIP^{*}

WITH PARTICULAR REFERENCE TO LYMPH-NODE METASTASES

BY ROBERT H. KENNEDY, M.D.

OF NEW YORK, N. Y.

FROM THE SURGICAL SERVICE, STUYVESANT SQUARE HOSPITAL

For several years past the treatment of epithelioma of the lip has been relegated more often to the radiologist. Early excision of the cervical lymph-nodes has become correspondingly less common. Radiation treatment of the neck is often used accompanying or following the treatment of the local lesion. If enlarged nodes appear, some advise block excision or partial excision together with the insertion of radium. The present series of cases is analyzed with the idea of placing on record the findings when the initial treatment is exclusively surgical.

In no other part of the body except head and extremities does any surgeon consider that he is doing a proper operation for cancer, unless he removes the regional lymph-nodes. For a surgeon to perform a simple mastectomy in the presence of apparently early carcinoma of the breast would be considered by most men a rank injustice to the patient. If regional lymph-nodes after removal fail to show the presence of carcinoma, it does not mean that an unnecessary operation has been performed. The pathologist simply has not found carcinoma in any of the sections which he examined. Naturally, he does not make serial sections of all the tissue sent him, but of nodes or regions which seem suspicious to him. Theoretically, at least, it is possible for one or a few metastatic cells to be present in a regional lymph-node and impracticable for the pathologist to find them. It is not proper to neglect doing a regional node dissection and allow such deposits to grow.

Squamous-cell epithelioma is a potentially metastasizing disease, no matter what the location. If the danger of operation is not too great, we have no right to jeopardize the life of the patient because a given lesion metastasizes seldom or slowly, because it is of short duration, small size, or of a certain grade. It is generally considered that the chances of complete removal of the disease are greater if a small node, impalpable before operation, is found involved than if a large, easily palpable node is present. It is much more important in the life of the patient to do a complete operation when no nodes are palpable, than it is after these become palpable.

Beresow¹ sent a questionnaire concerning the necessity of removing submaxillary and submental nodes in such patients. Among fifty replies he found thirty-eight in favor of it and twelve opposed unless there were special indications. Stout² states that "the presence of lymph-node metastases decreases the chances of survival to an enormous degree." Shedden³ found that with lymph-node metastases in lip cases, the percentage of good results from treatment was halved. Evidently, the general feeling is that once lymph-nodes become obviously involved the patient's chances of life are markedly lessened.

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Taussig⁴ says "Involved regional lymph-nodes should be removed surgically when this is feasible" Blair⁵ states that "there may be no microscopical evidence of malignancy in the regional glands, but this does not necessarily mean that the glands are not affected" In an editorial article⁶ in the American Journal of Cancer, the writer states that "some years later the nodes in the neck (in lip cases) may show evidence of metastases Cancer-cells have evidently been present during the entire period, growing steadily until the tumors have reached microscopical size", also, "two or three years later nodes have appeared in the neck with the inevitable termination"

On the other hand, in lip cases Regard⁷ believes in radical neck dissection when there are lymph-nodes present suspected of being malignant, but that otherwise it is unnecessary because the neck can be watched closely Quick⁸ recommends radiation treatment of the neck when there is no evidence of involvement of the nodes, based on the premise that the nodes have a protective reaction against carcinoma If the local lesion is removed with reasonable certainty, I know of no basis for expecting a lymph-node, which may be the resting place of cancer cells, to protect against local cancer no longer present Pancoast⁹ says "Certainly to us routine block dissections seem superfluous" Dorrance¹⁰ says "My mortality has been rather high in block dissection of the neck" Meland¹¹ believes that neck dissection is superfluous in 50 per cent of cases, but does not give pathological reports nor follow-up results Neill¹² says that "in the early cases with no palpable glands with a patient available for frequent observation, we feel it safe to wait and watch" He gives no statistics

Further excerpts from the references show the same marked difference of opinion It seems to me that the burden of proof rests on the radiologists to show that their results are better over a period of years than those shown by surgical treatment I have been unable to find any such detailed statistics Burkett,¹³ a radiologist, says "With an experienced operator and a regular assistant, the operation is not so formidable as it appears and I am convinced that it is one of the best surgical operations in malignant disease The tragedy is that so many block dissections are so only in name"

The present series is composed of 246 patients who have been operated on for squamous-cell epithelioma of the lip at the Stuyvesant Square Hospital (formerly the New York Skin and Cancer Hospital) During the same period there have been two cases of sarcoma of the lip Two hundred and forty patients were men and six were women One woman had a typical lesion on the upper lip and another had a grade II lesion

Age by Decades

20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
6	20	43	81	56	31	7	1

Age not given—1

That is, one-third of these lesions occurred between the ages of fifty and fifty-nine and almost one-quarter between sixty and sixty-nine The youngest patients were two at twenty-six years and the oldest one at ninety-one years

Etiology—Of the 209 histories which mentioned tobacco, 93 per cent of the patients admitted its use and 53 per cent its use in large quantities (See Table I)

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TABLE I
Use of Tobacco

Denied	15
Admitted, extent not stated	41
Moderate	43
Heavy	110
Not mentioned	37
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	246

The method of using tobacco was mentioned as follows

Pipe by	103 patients
Cigarettes by	37 patients
Cigars by	33 patients
Chewing tobacco by	7 patients

Nineteen patients mentioned that they were in the habit of holding the pipe or cigarette at the site where the lesion commenced

A large majority of these patients required considerable oral hygiene

One fisherman gave as a possible cause injury to his lip "from holding needles in the mouth" Another patient denied smoking but kept nails in his mouth much of the time while working

Duration of Lesion According to Patient's History—This was not mentioned on thirteen charts Twenty-nine patients stated that they had had the lesion for three years or longer, as follows

Three years	6	Ten years	3
Four years	4	Eleven years	1
Five years	5	Twelve years	1
Six years	3	Eighteen years	1
Seven years	1	Forty years	1
Nine years	3		<hr/>
			29

Eight of these were recurrences after one or more treatments elsewhere For the remainder this was their first treatment In some of these the condition was probably not cancer for the entire length of time during which they had noted the lesion and, therefore, this group is not considered in the average time before treatment

For the remaining 204 patients, the duration of the lesion averaged 90 months before admission (See Table II) During this time many had self-prescribed or drug-store treatment by salves Only twenty-seven of these had been previously treated by physicians Eleven had received radium, two X-ray treatment, fourteen "burned with electric needle" or other form of cauterization Taking into account the time at which these twenty-seven applied to a physician for treatment, the average time before these 204 patients visited any physician was 82 months This figure is particularly striking when we consider that this lesion is about the easiest of any cancer in the body for the patient to see It shows the necessity of increased efforts to educate the public

TABLE II

Duration Before Hospital Admission

(204 patients)			
One month	7	Seven-Nine months	19
Two months	21	Ten-Twelve months	32
Three months	24	Thirteen-Eighteen months	19
Four months	17	Nineteen-Twenty-four months	21
Five months	15	Thirty months	3
Six months	26		

It will be seen, however, that 110, or 54 per cent, presented themselves for treatment within six months of the time that they noted the lesion, and 161, or 79 per cent, within one year

One hundred and fifty-six of the lesions (63 per cent) had progressed to the stage of ulceration when admitted to the hospital

Size and Site of Lesion—The size of the lesion was mentioned on 232 charts as follows

Up to 1.5 cm,	80, or 35 per cent
1.5 to 3 cm,	103, or 44 per cent
Over 3 cm,	49, or 21 per cent

In Pfahler's¹⁴ series, 58 per cent of his patients were in the first group. Several of our last group involved the whole lower lip. It is to be noted that practically two-thirds of the patients must be considered as having extensive lesions.

The upper lip was involved in two patients, 0.8 per cent. In the remaining 244 patients, the lower lip was involved. One of the two with an upper-lip lesion was a woman.

The position on the lip was noted on 228 charts as follows (the lip being divided into right, left and middle thirds): right third, eighty-one; left third, eighty-one; middle third, sixty-six. In the extensive lesions, of course, more than one-third was encroached upon, but the case is entered under the third which showed the most involvement.

Presence of Lymph-nodes on Clinical Examination—Whether cervical lymph-nodes were palpable on examination before operation is not mentioned in eighty-four instances. Of the remaining 162 patients, it is stated that no lymph-nodes were felt in sixty-four, or 40 per cent, and that they were palpable in ninety-eight, or 60 per cent. It is rarely mentioned whether, in the opinion of the examiner, these nodes were of malignant nature. Usually, the site only is given, *e.g.*, submaxillary. Twice the nodes were stated to be "soft," once "thought inflammatory" and once "believed cancerous." In all of these patients, hyperplasia only was found histologically. In one patient it was stated that enlarged nodes were felt in one submaxillary region, but since they were soft it was believed that they were not involved. These proved, however, to be metastases. Pfahler¹⁴ shows in his series that 16 per cent had palpable lymph-nodes, compared with 60 per cent in this series.

In the ninety-eight patients in whom lymph-nodes were felt and neck

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dissections were done, the tissue examination proved that metastases were present in thirty-two, or 33 per cent, and hyperplasia only was found in sixty-six, or 67 per cent

In the sixty-four patients in whom no lymph-nodes were felt and neck dissections were done, the tissue examination proved that metastases were present in nine, or 14 per cent, while hyperplasia only was found in fifty-five, or 86 per cent

Metastases were found in five patients about whom there is no statement regarding the presence of enlarged nodes on physical examination. That is, lymph-node metastases were found histologically in a total of forty-six patients, or 24 per cent of those in whom lymph-node dissections were done

Age by Decades of Patients with Cervical Metastases

30-39	40-49	50-59	60-69	70-79	80-89	not given
2	6	16	12	8	1	1

There is only slight difference from the general average in the age of those patients with lymph-node metastases, *i e*, slightly over one-third occurred between the ages of fifty and slightly over one-quarter between sixty and sixty-nine. There is at least no evidence that younger patients are more likely to have lymph-node metastases. If anything, the average age of the patients with metastases is somewhat greater than the general average

Duration of Lesion of Patients with Cervical Lymph-node Metastases—Seven patients stated that they had noted the growth for three years or longer, as follows

Three years	3	Nine years	1
Five years	1	Ten years	1
Six years	1		—
			7

This is 15 per cent of the total with lymph-node metastases while in the general average 12 per cent had a duration of three years or over

For the remaining thirty-nine, the duration of the lesion averaged 11.3 months before the patients applied for treatment, *i e*, 2.3 months more than the general average (See Table III)

TABLE III

Duration of Lesion of Thirty-nine Patients with Cervical Metastases

One month	1	Seven months	2
Two months	4	Eight months	1
Three months	3	Nine-Twelve months	8
Four months	2	Thirteen-Eighteen months	3
Five months	2	Nineteen-Twenty-four months	9
Six months	4		

Sixteen, or 41 per cent, came for treatment within six months and twenty-seven, or 69 per cent, within one year. That is, the average duration of the lesion of the patients with lymph-node metastases is definitely longer

than that of the general average although metastases were found in one patient one month after the lesion appeared and in four others after two months. Brief duration of the lesion does not, therefore, assure safety from metastases.

The size of the lesion was given in thirty-nine of these patients with lymph-node metastases as follows

Up to 1.5 cm,	2, or 5 per cent
1.5 to 3 cm,	22, or 56 per cent
Over 3 cm,	15, or 39 per cent

—
39

The percentage of lesions 1.5 to 3 centimetres in size is larger than that in the average, while the percentage of lesions over 3 centimetres in size is almost twice that of the average. On the other hand, one lesion 5 centimetres in diameter and another 1 centimetre in diameter had already metastasized, showing that small size does not guarantee safety from metastases being present.

The grade of the lip lesion is given in twenty of these patients with metastases. Eighteen were grade I and two grade II. In this small group it would not seem that the grade plays an important part in the danger of metastasis. One grade II lesion was in a man of fifty-one, of six months' duration and 1.5 centimetres in diameter and the other in a man of forty-four, of four months' duration and 3 centimetres in size.

Operations—These operations were performed by thirty-nine different surgeons, twenty-three of the visiting staff and sixteen of the resident staff. The operation on the lip consisted of a V excision in 182 patients, a more extensive excision requiring a plastic closure, frequently a modified Dieffenbach, in fifty-nine, a mucous-membrane excision in three, and in two patients no lip operation was done at this hospital. We have had little experience with radiation treatment of the lip lesion and therefore have formed no opinion of its value.

Excision of the cervical lymph-nodes was done as follows

Block dissection of one side to the omo-hyoid muscle	99
Block dissection of both sides to the omo-hyoid muscle at two operations	48
Block dissection of both sides to the omo-hyoid muscle at one operation	10
Excision of upper cervical nodes both sides at one operation	36
Excision of single node only	3
Excision of supraclavicular nodes (at another operation)	3

That is, 196 patients had lymph-nodes excised to some extent. On fifty patients no lymph-node excision was done. The reasons for this were the superficial character of the lip lesion, age of the patient, general condition of the patient, or refusal of the patient to have the operation performed. Eighty per cent of the 246 patients had lymph-node excisions. On 193 patients 244 major neck dissections were performed.

Of the ten patients on whom bilateral block dissection to the omohyoid

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muscle was performed at one operation, four died. We discarded this operation about seven years ago and strongly advise against it. The time involved and the shock of the procedure are too great. The three supra-clavicular node dissections were done on patients in whom involved nodes were found in the upper part of the neck. The operation of excision of the submaxillary, submental and carotid nodes on both sides as one procedure has been replaced for several years past by a block dissection to the omohyoid muscle. If necessary to do both sides, the second is done at a subsequent operation. The technic followed is that described by Semken in Nelson's Loose-Leaf Living Surgery, vol. 11, pp. 867-879. The three patients who had a single lymph-node excised had superficial lesions and one enlarged node. In each case the node showed hyperplasia only.

Operative Mortality—This should be based on the 193 patients who had major neck operations. In the remainder there was no mortality. Of the 193 patients, there were twenty-two deaths in the hospital, a mortality of 11.4 per cent. The age of the patients who died was 40-49, one, 50-59, eight, 60-69, eight, 70-79, five, *i.e.*, 59 per cent were over sixty years of age, whereas only 39 per cent of all the patients were over sixty. The size of the lesion in those who died was up to 15 centimetres, one, 15-3 centimetres, ten, over 3 centimetres, six, no record, five. Two are mentioned as involving the whole lower lip and two, two-thirds of the lip.

The excised lymph-nodes showed squamous-cell epithelioma in nine patients, hyperplasia only in twelve, and the report of one patient has been lost.

The cause of death was as follows:

Shock, block dissection of both sides of neck at one operation	4
Shock, double Dieffenbach cheiloplasty with dissection of upper cervical nodes both sides	1
Shock, extensive lip plastic with block dissection one side	1
Shock, block dissection one side, extensive lip excision, partial resection of lower jaw	1
Shock, block dissection	1
Shock, block dissection, second operation	1
Shock, block dissection, third operation	1
Pneumonia	6
Acute cardiac dilatation	1
Secondary hæmorrhage	3
Septicæmia, death on nineteenth day	1
(This patient was operated on only three weeks after radium treatment and had a necrosis of the entire surface of the wound.)	
Necrosis of the rectum, bronchopneumonia	1
This was the only accident of this kind which we have seen from colonic anæsthesia.)	

There is much to be learned from this chart. Block dissection of both sides of the neck should never be done at one operation. Other extensive pro-

cedures are preferably done in two or more stages. If both sides are done, sufficient time should elapse between neck dissections for the patient to recuperate, preferably over a period of one or two weeks outside the hospital. Following the use of radium all evidence of reaction must have disappeared for a period before operation is attempted. This should be at least six weeks after radiation. With these factors in mind we have had one death in the last sixty-six patients and no deaths in the last forty-six patients.

For several years past in addition to the treatment mentioned above, all patients have received a course of deep X-ray therapy to the neck after the wounds have healed. Thereby we attempt to give them the advantage of as complete treatment as possible. We do not use pre-operative radiation therapy.

Cosmetic Result—The wounds usually heal promptly. There is considerable œdema, often for several months. This is particularly marked in the upper flap extending over the ramus of the jaw. I have never seen it remain permanently. When it disappears, a scarcely visible scar remains. The lower branch of the facial nerve is always sacrificed in the course of the dissection. This allows one corner of the mouth to droop, but does not cause an unsightly deformity. The spinal accessory nerve is usually cut before it enters the sternomastoid muscle and resutured. It does not always regain its function, but even so the patients complain but little of the loss of use of the trapezius. Pain in the shoulder region is sometimes complained of for a few months, but constitutes an annoying rather than a serious sequela.

Recurrences—*Lip*—There have been seven possible local recurrences in the lip region, although in several of these it is probable that the condition was a new lesion, a recurrence.

(1) At five months, originally a large lesion with involvement of both submaxillary regions. Radiation. Died four months later.

(2) At one and one-half years, adjacent to scar, reoperated, well one year later. Showed metastases in left submaxillary region at original operation.

(3) At two and one-half years, in an adjacent leucoplakia of the buccal mucous membrane. This had been present for many years. Well three years after removal of latter lesion.

(4) Central squamous-cell lesion of the lip excised at another hospital one week before the patient's admission to Stuyvesant Square Hospital. Ulcer on admission excised, no carcinoma, both sides of the neck done. The left side showed carcinoma in a submaxillary node. Thirteen months later squamous-cell epithelioma of left side of lip excised, six weeks' duration. Ten months after this had another lesion removed from between the two scars which proved to be keratosis. Two and a half years later had another squamous-cell lesion excised from right side of lip not near the other scars. During all this time he continued to smoke a pipe against all advice. He never showed any further metastases in the neck. He was last seen five years and nine months after the first operation and one month after the last operation at which time he showed no evidence of recurrence. He died two months later in another hospital of myocarditis, aged sixty-three. These lesions were believed by all who saw him to be new involvements and not recurrences.

(5) At eight and one-half years lesion at site of old scar, excised, well two years later.

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(6) Fourteen and one-half years before, a lesion was removed from the right central portion of lip and an upper right neck dissection was done at this hospital. Carcinoma was found in the nodes. Now showed a lesion in the left central area which was excised and the left upper neck done. These nodes showed no metastases. Promptly showed metastases in the right supraclavicular region which were excised, but patient went on to death in a few months.

(7) A woman had an epithelioma of the lip excised in 1914. In 1920, had a lesion of the same area, of three months' duration, excised and the right cervical lymph-nodes removed. In 1931, had a recurrence, of four months' duration, at the same site, excised. All were grade I lesions. She was well one and one-half years later at the age of seventy-four with no evidence of metastases.

In four of these patients the lymph-nodes were found involved at the first operation.

Regional Recurrences—Nine patients are known to have shown regional involvement after lymph-node excision was performed.

(1) Almost immediate recurrence in neck and had further operations at three months and ten months. He was never free of carcinoma and committed suicide fourteen months after the first operation.

(2) In parotid nodes at four months. Operation. Well one year and seven months later.

(3) At six months developed a rapidly growing lesion just beneath zygoma and died. One does not expect lymphatic tissue at this site, nor drainage in this direction. This may have been a primary prickle-cell epithelioma of the face.

(4) In neck at seven months, no details.

(5) In neck at eight months, no details.

(6) At nine months in platysma muscle, died, date unknown.

(7) The submaxillary gland was attached to the jaw and it was known that the removal was incomplete. Recurrence was evident nine months later.

(8) In lower jaw at one and one-half years, died at two years.

(9) See Case VI under local recurrences.

Only one of these patients is known to be alive. All except No. 3 showed involvement of the lymph-nodes at the first operation.

Known Deaths after Discharge from the Hospital, Twenty-seven

From carcinoma, eleven

In addition to the eight mentioned above three others are believed to have died of carcinoma. They had lymph-node involvement at the first operation. One of these died of carcinoma of the oesophagus without other evidence of metastasis at five years. The average life after operation in the remaining ten was thirteen months.

From other causes, four

Four are known to have died of other causes without any evidence of recurrence or metastases.

(1) At six weeks—"acute indigestion"

(2) At two years and four months—cerebral hæmorrhage

(3) At three years—angina pectoris

(4) At six years—myocarditis

Cause unknown, twelve

Carcinoma cannot be excluded in these. The time after operation varied from seven months to four and one-half years, the average being twenty-

seven months One of these had lymph-node involvement at the first operation

Late Results in Patients without Recurrence—This is known in ninety-three patients, sixty of whom are alive and well for a period over three years and thirty-one for over five years The result according to extent of operation and findings is shown in Table IV The follow-up in these patients for a period of years is difficult, since they can see no apparent reason to continue to return

TABLE IV

Follow-up Results According to Extent of Operation and Findings

	Lip Excision Only	Neck Dissection Also, No Carcinoma Found in Nodes	Neck Dissection Also, Carcinoma Found in Nodes
Total number of patients	50	150	46
Number of patients followed and well without recurrence or metastases	13	69	11
Up to 1 year		2	
1- 2 years		11	
2- 3 years	4	12	4
3- 4 years		11	1
4- 5 years	3	11	3
5- 6 years	2	8	1
6- 7 years	1	3	1
7- 8 years	1	7	
8- 9 years	1	3	
9-10 years	1	1	1
	—	—	—
	13	69	11

It is to be noted that seven patients who had carcinoma in the cervical nodes at time of operation are well for a period over three years

The period for which patients are well with no recurrence compared to the size of the lip lesion is shown in Table V

TABLE V

Follow-up Results According to Size of Lesion

No Recurrence	Lesion up to 1.5 cm	1.5-3 cm	Over 3 cm
Up to 1 year		2	
1- 2 years	4	5	2
2- 3 years	4	13	3
3- 4 years	7	4	1
4- 5 years	4	7	4
5- 6 years	5	5	1
6- 7 years	3	2	
7- 8 years	4	4	
8- 9 years	3	1	
9-10 years	2		1
	—	—	—
	36	43	12

The size was not stated on two charts

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It is to be noted that seven patients with lesions over 3 centimetres in size are well for a period over three years and twenty-three patients with lesions 1.5-3 centimetres in size are all well for the same period

We know the result on nine patients whose lip lesion showed grade II carcinoma. They were well for the following periods

1-2 years, 1	4-5 years, 2
2-3 years, 1	5-6 years, 2
3-4 years, 3	

For the whole series the present result is known in 147 patients. Forty-nine, or 33 per cent, are dead, and ninety-eight, or 67 per cent, are living. Twenty-two died in the hospital and twenty-seven since leaving the hospital. Of the latter, four are known to have shown no clinical evidence of cancer at the time of death from other causes. Six others lived over three years before death, in five of these the cause being unknown and in the sixth carcinoma of the œsophagus. Of the ninety-eight living, four have had local recurrence, one a lymph-node recurrence and the remaining ninety-three have had no recurrence for varying periods.

Of the forty-six patients in whom cervical metastases were found on histological examination, nine died in the hospital. After leaving the hospital, ten died of carcinoma, one at six years of myocarditis, and one of unknown cause. In fourteen the result is unknown. Eleven, or 24 per cent, of the forty-six patients are alive and without clinical recurrence. Of the thirty-two known results, 34 per cent are alive and well.

The total known results according to the size of the lesion are shown in Table VI. It is to be noted that while 88 per cent of the patients with lesions up to 1.5 centimetres in size are alive and well, this is true of only 44 per cent of those with lesions over 3 centimetres in size.

TABLE VI
Total Known Results According to Size of Lesion

	Lesion—Up to 1.5 cm	1.5-3 cm	Over 3 cm
Died in hospital	1	10	6
Died after leaving hospital from cancer or unknown cause	4	10	9
Died after leaving hospital from other cause and known to be clinically free from cancer		4	
Well after local recurrence		4	
Well after lymph-node recurrence		1	
Well—no recurrence	36	43	12
	—	—	—
	41	72	27
Per cent alive and well	88%	67%	44%

The size was not stated on seven charts

This series may be considered a fair cross-section of what may be expected of general surgical treatment. Inasmuch as the operations were performed by thirty-nine different surgeons, it can hardly be said that all were

specialists in this type of work. However, all tried to carry out thorough dissections of the neck according to standardized technic. A hospital mortality of 11.4 per cent is high for any operation, although the fact that the average age is in the sixth decade must be taken into consideration. But with one death in the last sixty-six patients, we hope that attention to factors brought out in the analysis of the operative deaths will continue to show a decrease in the mortality rate.

Many of the patients operated upon would have been considered inoperable in other institutions and this has increased both the hospital mortality rate and the number of deaths after leaving the hospital following operation. But some of these patients, who might be considered inoperable, have remained well without recurrence for years. To save even a few of them seems worth the high mortality, when it is admitted that in such patients there is no other treatment at present except palliation.

Since 33 per cent of the patients with palpable lymph-nodes and 14 per cent of those without palpable lymph-nodes showed metastases, it seems necessary to remove the area of regional drainage as soon as the local lesion has been eradicated. It would seem that in an average group of patients over 25 per cent will have lymph-node metastases when first presenting themselves for treatment. Whether these are palpable or not, the chances of permanent cure are better if the lymphatic drainage area is removed at this time. To delay until the appearance of clinically malignant nodes does not give the patient as good a chance of life as to remove potentially malignant lymph-nodes whether proved metastases are found or not.

There is one serious difficulty in using radium for treatment of the local lesion. The neck dissection should not be done until we believe that there are no cells remaining in the local area capable of metastasizing. By this time the patient is cured as far as he can see and one encounters great difficulty in persuading him of the necessity of an operation on the neck. If one side of the neck is operated upon at the same time that the lip lesion is excised, we have progressed farther toward the cure of the patient.

Even if we grant that neck dissection in 50 per cent of the cases is superfluous (Meland¹¹), I can find no criteria as to age, size of lesion, duration of lesion or grading which will determine beforehand which are the necessary, and which the superfluous, dissections.

SUMMARY

(1) Two hundred and forty-six cases of squamous-cell epithelioma of the lip treated at the Stuyvesant Square Hospital are analyzed. Six patients were women.

(2) One-third of the lesions occurred in patients between the ages of fifty and fifty-nine.

(3) Ninety-three per cent of the patients admitted the use of tobacco and 53 per cent its use in large quantities.

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(4) The duration of the lesion averaged over nine months before hospital admission

(5) Two-thirds of the patients had extensive lesions on admission

(6) The upper lip was involved twice

(7) Palpable cervical lymph-nodes were present in 60 per cent of the patients and 33 per cent of these proved to be metastases

(8) Metastases were found in 14 per cent of patients in whom no cervical lymph-nodes could be felt

(9) In patients with metastases the average age is somewhat greater and the duration of the lesion somewhat longer

(10) Brief duration or small size does not guarantee safety from metastasis

(11) The grade of the lesion does not appear to influence metastasis

(12) Eighty per cent of the patients had lymph-node excisions

(13) Two hundred and forty-four neck dissections were performed

(14) The hospital mortality of the patients having neck dissections was 11.4 per cent

(15) Block dissection of both sides of the neck at one operation has been discarded

(16) The present result is known in 147 patients, 67 per cent of whom are alive and well. Sixty of these are well after more than three years and thirty-one after more than five years

(17) The present result is known in thirty-two patients with metastases, 34 per cent of whom are alive and well. Seven of these are well for more than three years

(18) Eighty-eight per cent of patients with lesions up to 1.5 centimetres are alive and well, 67 per cent of those between 1.5 and 3 centimetres and 44 per cent of those with lesions over 3 centimetres in size

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PALATOPLASTY USING EXTRA-ORAL TISSUES

By ALBERT D. DAVIS, D.D.S., M.D.

OF SAN FRANCISCO, CAL.

FROM THE DEPARTMENT OF SURGERY OF THE STANFORD UNIVERSITY

THE use of extra-oral tissues for the closure of large palatal defects has been subjected to both praise and criticism, according to the viewpoint of the individual author. Persistently critical are those who advocate the use of especially constructed dental prostheses known as obturators. Equally censorious are those who would sacrifice the upper teeth and their investing structures either in part or in whole, together with adjacent tissues of lips or cheeks in order to obtain a closure intra-orally.

Advocates of the use of extra-oral tissues have devised various methods



FIG 1

FIG 2

FIG 1—Condition prior to operations. The Brophy reflectoscope is in place and the edges of the defect are clearly visible. Unfortunately the posterior part of the palate could not be shown. (See Fig. 11 which shows the east of the mouth also Fig. 3.)

FIG 2—Tubed pedicle on left side of abdomen prior to removal of stitches

unique and ingenious for closure. Flaps from the forehead, pharyngeal flaps, flaps from the arm similar to those used in Italian rhinoplasty, transplantation of fingers, nasio-labial flaps, flaps from the neck and chest have all been used. The tubed pedicle flap, either *per se*, or with cartilage or bone inclusions or insertions, has been utilized by few surgeons for closure of large defects.

In reviewing the literature the author finds many operations designed which produce additional deformity at the expense of closure. Furthermore, flaps which do not provide an epithelialized nasal, as well as oral, surface are subject to failure and infection. Any operation designed which will produce a velum, flexible enough to admit of free movement, long enough to permit closure of the oro-pharynx by the dorsum of the tongue, and free from surgically produced deformities should be the one of choice. The

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case herein presented offered so many interesting phases before completion that a report of the various steps is given

CASE—Miss L. P., aged fifteen, presented a large central defect of the palate, measuring 28 by 16 millimetres. A small bridge of tissue, approximately 4 millimetres wide, connected the two lateral halves, and faded away on each side leaving the characteristic large inverted "V" type opening posteriorly. Several previous operations had been performed, and sloughing of the central portion had occurred (Fig. 1). The upper lip was scarred and tightly bound down to the alveolar ridge, particularly on the right side, making the lower jaw appear prognathous. All upper teeth, except the two first molars and a malposed second right bicuspid had been removed preparatory



FIG 3

FIG 3—Posterior part of palate prior to lengthening



FIG 4

FIG 4—Length of palate obtained by using parts of the palatopharyngeus muscle on each side

to the making of an artificial prosthesis to cover the opening. A desire for a more nearly normal reconstruction prompted the series of operations which followed. A tubed pedicle flap was made on the abdomen after the manner of Sir Harold Gillies (Fig. 2). The abdomen was selected for the reason that any resultant scars would be in "unseen" areas. The pedicle was made approximately double the width of the widest measurement of the defect to allow for contracture after the removal of all fat.

During the interval of waiting for blood supply to be established in the tubed pedicle a triangular flap was taken from the lower lip and added to the tightly bound flat upper lip as described by Abbe. This gave better access to the mouth released the upper lip and improved the general appearance of the profile. A short time later the pedicle was released from the upper end and fastened to the thenar eminence of the left hand and the arm was bound to the side by plaster bandages until healing occurred. During the interval of time while the blood supply was being established from the hand to the pedicle, the palate was lengthened by utilizing two-thirds of each palato-

pharyngeus muscle, and uniting them in the median line—an increase of over one inch being obtained (See Brophy, Cleft Lip and Palate, page 253) (Figs 3 and 4)

The next step released the tubed pedicle entirely from the abdomen, and using the arm as a carrier, the pedicle was transferred to the mouth where its free end was united to the freshened edges of the anterior portion of the defect, the patient being encased in a plaster spica to prevent displacement. Feeding by nasal tube was used (Fig 5)

Three weeks later the tubed pedicle was excised from the arm and the arm released (Fig 6). A few days later the free end of the pedicle was turned backward,



FIG 5—The arm has been used as a carrier to bring the pedicle to the mouth. The pedicle has been sutured to the anterior part of the defect and the patient encased in a plaster spica.

and sutured into position on the freshened edges of the distal portion of the defect (Fig 7). During this period the jaws were kept apart by means of a Brophy reflectoscope, the tongue being depressed as well, and nasal feeding continued for ten days. There was now in position a double epithelialized flap, originally obtained from the abdominal wall, receiving its entire nourishment from its anterior and posterior insertions in the palate.

The next step in operative procedure was undertaken with some trepidation as to the outcome. The lateral edges of the defect were scarred and inverted. The blood supply, normally good, was questionable unless sufficient excision of the curled edges was made. Fortunately, enough width was present on the pedicle to allow for this

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Fig 6—The pedicle has been detached from the rim, and is shown protruding from the mouth

Fig 7—The free end of the pedicle has been swung backward and sutured to the posterior edge of the defect

Fig 8—The sides of the pedicle have been opened, the fat removed and sutured to the sides of the defect



condition The right side of the pedicle was opened and the fat removed to the median line, leaving only the full thickness skin surfaces A flap was raised from the bone



FIG 9

FIG 10

FIG 9—Skin graft in position showing depth of sulcus obtained
FIG 10—Denture in place Note the increase in size of lip obtained by the Abbe operation



FIG 11—Cast of mouth before operations

FIG 12—Cast of mouth after operative procedures

on the right side, and the edge of the defect was excised and split The nasal surface was sutured with chromic gut No 100, and the palatal surface with horsehair to the split edge of the pedicle At the same time the malposed bicuspid tooth was removed from the left side to allow for additional tissue needed in that area

PALATOPLASTY

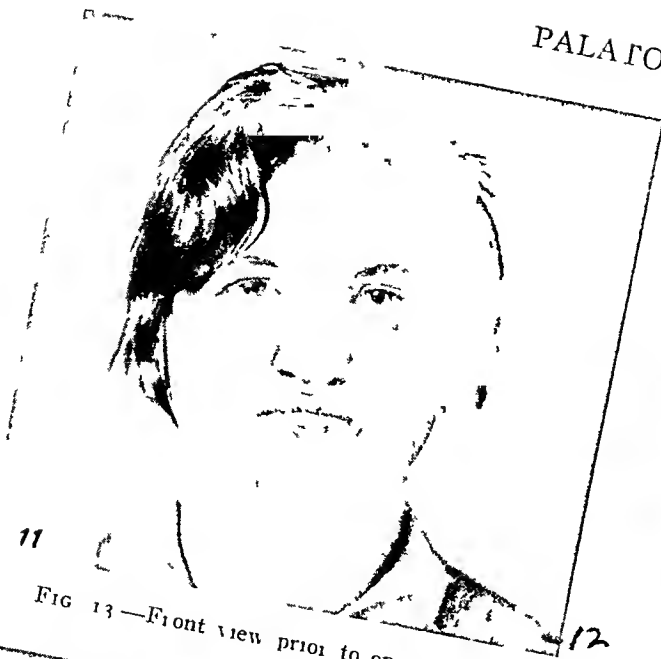


Fig 13—Front view prior to operations



Fig 14—Front view after operative procedures



Fig 15—Left profile before operations



Fig 16—Left profile after operative procedures



Fig 17—Right profile before operations



Fig 18—Right profile after operative procedures

About a month later the left side of the pedicle was opened and sutured to the edges of the defect on the left. A small opening appeared on the seventh day, and refreshing and suturing were necessary later. This was done and the defect was closed, making an air- and water-proof closure (Fig 8). The patient now had a double epithelialized flap covering the entire defect, but upon investigation it was found that there was still a very flat labial and buccal sulcus under the upper lip. Inasmuch as a denture was needed to supply the missing teeth, and its success was dependent upon its proper seating, it was obvious that the more surface it rested upon the better result would be obtained. In addition, the labial portion of the denture was to be utilized in keeping the upper lip projected outward in order to gain the desired æsthetic result. Therefore, an upper temporary denture was constructed, and under block anæsthesia an incision was made in the fold of the buccal sulcus from one first molar around under the lip to the opposite molar. All scar tissue was removed and the lip was dissected up to the nose and high up on the maxilla on each side. A skin graft was cut from a non-hairy area on the thigh, "stent" was heated and added to the upper ridge of the denture, and while still soft, an impression was taken of the raw area. This was carefully moulded and shaped until the desired effect was produced. The Thiersch graft was then draped over the "stent" raw side outward, and the denture (bearing the added "stent") and graft was placed in position—the jaws immobilized in plaster and left for ten days. The increased sulcus was very satisfactory (Fig 9). The denture was then sent to the laboratory and the additional rubber added to replace the "stent," and the permanent prosthesis was placed (Fig 10).

The end-result was quite pleasing, not only cosmetically but functionally. The psychological effect on the patient was quite marked—plans which before had been put aside as impossible with her deformity were now to be realized, and the first step was the beginning of a college career (Figs 11, 12, 13, 14, 15, 16, 17 and 18).

PRESERVATION OF INNERVATION AND CIRCULATION SUPPLY IN PLASTIC RESTORATION OF UPPER LIP

BY JOHANNES F S ESSER, M D
OF MONACO

"BIOLOGICAL OR ARTERY FLAPS" is the name I have given to flaps of skin which may contain other tissue such as muscle, fat, *etc*, all belonging to the territory of given lymph-vessels, arteries and nourished by these vessels and their branches, evacuated by the accompanying veins. Their pedicle contains little more than these vessels. In order that such a flap may remain alive when cut from its surrounding tissue, the following conditions are necessary: (a) Supply of nourishment by the artery and vessels. (b) Outlet, by means of vessels, for the blood poisonous encreta, which are produced in the cells in proportion to their activity. It may happen that at first the vein does not function, but under arterial pressure it may resume its functions, or small branches may become enlarged, due to arterial pressure, or blood may escape into the wound, as when incisions are made in the wound or leeches applied. The escape of poisonous encreta is as important to the life of the tissue as the supply of nourishment by the artery, and it is better to have no vessels at all than an inflow of blood, causing great activity in the tissue, with no outlet for the poisons arising from this activity. A free transplanted flap would have a better chance of living than a flap with artery intact and veins and branches and lymph-vessels definitely destroyed. (c) The sympathetic, motor and sensory nerves play an important rôle in keeping alive the complicated cells of the tissue. The exact importance of this rôle has not been estimated, but in the case of highly specialized cells it has been proved that the death of the cell always occurs when the governing nerve supply is cut off, and this does not occur in the case of simpler tissue.

The pedicle thus contains only the artery, with the accompanying veins, nerves and lymphatics, surrounded only by loose protective tissue. There must be always enough of this surrounding tissue not only to prevent direct mutilation of the vessels themselves, but also to prevent branches being cut too near the main vessels, because the thrombus formed when a vessel is cut near the main vessel might too easily obstruct the circulation in the main vessel.

The idea underlying this method is, that while the skin itself in no way serves to keep alive the tissues of the flap, its presence gives rise when the pedicle is turned, to a pressure on the vessels and nerves of the pedicle. For it is apparent that when a pedicle containing a broad band of skin is turned as is often the case through an angle of 100° to 180° , there will be a stress

on the inner and a strain on the outer part of the pedicle, in proportion to the angle of torsion. In addition, the ribbon-like pedicle, owing to this pressure, tends to become tubular, and between the two halves the unfortunate vessels are subjected to pressure and the circulation possibly stopped owing to bending.

The disadvantage of the broad skin band in the pedicle increases in proportion to the degree of torsion, while there is no evidence to show that the skin itself aids in keeping alive the tissue of the flap, or that the necessary tissues cannot be kept intact when the skin of the pedicle is removed. Lastly, no skin is lost at the corrections and there is no need for later treatment of the pedicle.

The flaps resemble leaves, supported by a thin stalk, and may be very large themselves. There is no need to section the pedicle later. Perfect circulation and innervation are provided for and not only are the tissues preserved macroscopically but also the functions, less well known but possibly equally important, of the nervous system.

It is in cases in which operation was previously regarded as impossible that these flaps are significantly successful, such as, for example, when it is required at the same time to cover and heal a wound which is atonic, without circulation and vitality, and chronically infected. The flap, in such a case, has to graft itself without any assistance from the surrounding tissue, and must carry with it not only the nourishment necessary for itself, but a surplus to enable it to combat the poisons and toxins in the surrounding, and bring to it a new circulation. It is of great importance for burns by X-rays.

"Biological or Artery flaps" have great possibilities in operations on the face. The arteries which can be most usefully employed are the temporal, its ascending branch or the ramus anterior, the occipital, the frontal, the angular, the facial and its branches, and the eyelid artery. Many years after I introduced the above system one of my assistants met and showed me a small publication of Monks, who described one case with very long thin artery pedicle without generalising and developing its biological value. I never noticed this or other articles treating this subject before.

On other parts of the body many different arteries can be used, notably the inferior epigastric, which gives very suitable flaps for treating wounds on the lower limbs, on the abdomen or on the genitals, and the intercostal arteries.

Before tracing out the flap it is necessary to explore and find out the course of the artery by means of a careful palpation. This examination must be made before the local anaesthesia, and before washing the skin with alcohol or tincture of iodine, because the skin would otherwise be hardened, similarly, the examination is made before the surgeon's hands are washed and prepared. Care must be taken that the surgeon's own finger artery is not mistaken for the artery sought for. In very difficult cases, when I was uncertain as to the course of the artery, I have stopped the examination and recommenced next day early in the morning, when the senses are most acute.

The course of the artery having been ascertained and its path marked on the surface of the skin with tincture of iodine, the cutting of the pedicle and then of the flap is proceeded with. A shallow cut is made in the surface of the skin along the line of the artery, equal in length to the required length of the pedicle. From the bottom of this shallow cut, two deep cuts are made to the right and left each making an angle of 30° with the surface. These are the *roof cuts* and form the roof of the pedicle. These cuts gradually turn downwards till at the level of the artery they make an angle of 90° with the surface and should be between 0.3 centimetre and 0.5 centimetre on each side of the line where the vessels are situated.

As a rule the flap arises gradually from the pedicle and is pear-shaped. The perpendicular cuts on each side of the pedicle are continued to surround the flap the shape of which has been previously traced out and indicated with tincture of iodine. After this the flap is freed by undermining from below till the pedicle is reached and the pedicle itself is then freed by continuing the perpendicular side cuts inwardly, until they meet below the vessels, great care being taken to keep the artery protected by the surrounding tissue.

The size of the pedicle in cross-section may vary from the size of a match to that of a pencil and in length from 0.5 centimetre to several centimetres. Within the required limits the shorter the pedicle the less is the chance of damage to the vessels. A long pedicle is necessary only when it is desired to pass it through a long narrow tunnel or channel, and this is possible only when the flap itself is narrow as the flap itself would have to pass through such a tunnel. When the defect to be repaired is some distance from the place from which the flap is taken it is better to have a short pedicle and allow the flap to arise out of it very gradually so that it has the pear shape very much elongated than to have a long pedicle and less elongated flap but nevertheless flaps with long thin pedicles are often used.

The defect or wound which is to receive the flap is first of all prepared and a cut is made from the nearest point of the defect to the pedicle, to the pedicle itself. This cut which is to form a bed for the pedicle must be deep and wide enough for the pedicle to lie in it and to make this possible a certain amount of undermining of its tissues is often necessary especially in cases when it has to receive the beginning of the flaps as well as the pedicle. The pedicle and the beginning of the flap must be able to lie in it without any parts being high above the normal surface. The cut from the defect to the pedicle bifurcates at a distance of about one-half centimetre from the pedicle in the depth and the two resulting cuts continue obliquely until they merge with the roof cuts. The flap may then be brought into the defect and the pedicle brought into the bed, formed for it by these cuts.

Before sewing the covering over the pedicle and the edges of the flap, the secondary defect (i.e. the area from which the flap was taken) is treated. If possible, its edges are sewn together. But if this is impossible long 'loop stitches' of metallic thread (bronze silver or brass) are made, with

a few similar stitches of stray silk among them. These "loop stitches" are in pairs, each pair forming a complete hook and knotted. The stitch enters the surface of the skin about one centimetre from the edge of the defect, comes out into the wound, crosses above the wound, enters the flesh at the opposite side and emerges on the surface again about one centimetre from the border of the defect. Then it enters the skin again about one centimetre from where it emerged and one centimetre from the edge of the defect, and comes out into the wound, a piece of gauze is rolled firmly to form a hard "bean" and this is placed on the surface of the skin below the thread which is then drawn tightly over it to hold it in place. The thread then recrosses the wound, enters below the edge of the defect to emerge one centimetre from the point where it first entered and one centimetre from the edge of the defect. The thread as it crosses and recrosses the wound forms two parallel lines. A similar "bean" of gauze is placed on the skin between the entry and exit of the threads, and the ends of the thread are knotted firmly over it. The whole stitch is thus a complete and closed loop, having the shape of a link of a chain. I used these stitches to shut the large secondary defects, caused by taking pedicled flaps from one leg to the other as I described in 1917 (*Brunn's Beiträge*, Band 108, Heft 4, p. 514). Beneath these stitches is placed on the secondary defect wound a piece of skin (Thiersch graft) from the inner side of the upper arm or the inner side of the thigh. This skin is passed under the stitches across the wound, and by the stitches is kept in place in the wound under a certain amount of pressure. The places from which these grafts are taken are treated by brushing the surrounding skin with mastic solution, and without further dressings, as aseptic roller bandage is wound several times around the limb, covering the wound. After a few weeks this bandage, when unwound, will come freely from the wound, when the wound is healed and a new epidermis formed.

The edges of the flap are sewn to the edges of the original defect with the finest silk and without tension of any sort. Similarly, the edges of the groove or channel, in which the pedicle lies, are joined, and also the edges of the wound left by the removal of the pedicle. Compressing bandages should never be used on the flap and especially not on the turning of the pedicle. The region of the operation can be protected by sticking a piece of aseptic bandage over it, after having painted the surrounding skin with mastic solution. I prefer, however, to give no bandage at all, but to dust the region with a very small quantity of powdered calomel. This mixes with the secretions from the wound, which when dry, form the protective crust. As long as this crust remains dry, the calomel is inactive, but as soon as infection threatens and causes new secretions, the calomel is slowly changed into sublimate and this disinfects any fluid which may enter the wound. It is of the greatest importance to keep wounds dry, because fluid acts dangerously in carrying germs into the minute spaces in the tissues. An-

Fig 1—Arterial supply available for upper plastic. The lymph vessels and nerves always accompany the arteries

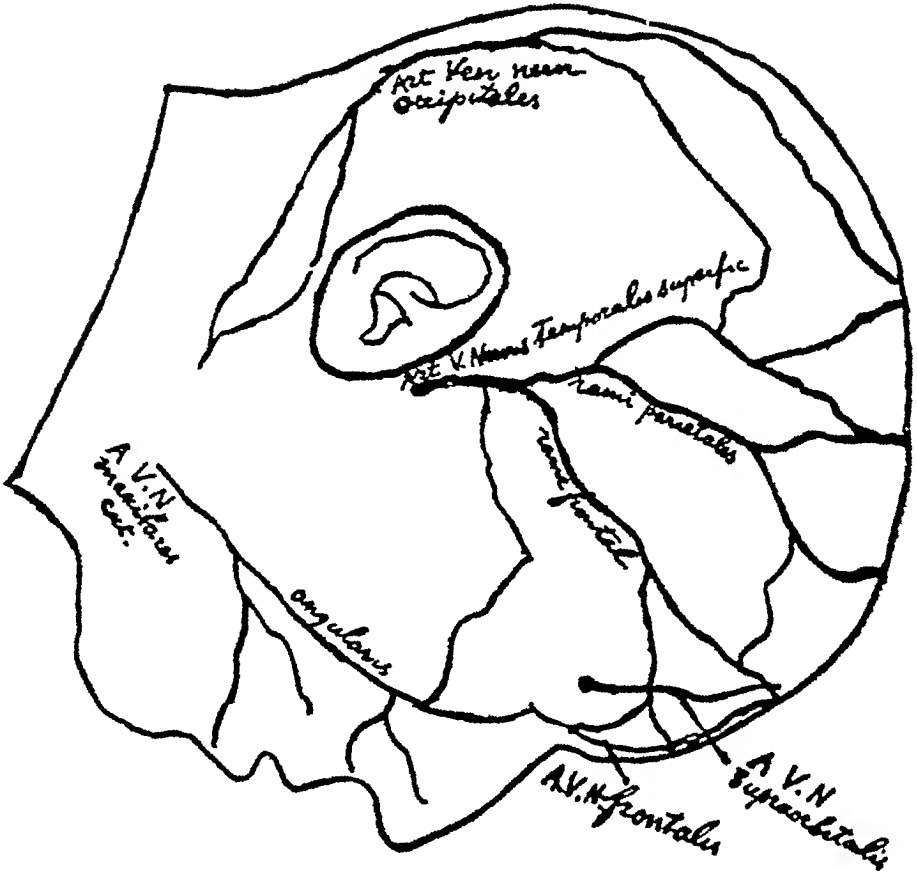
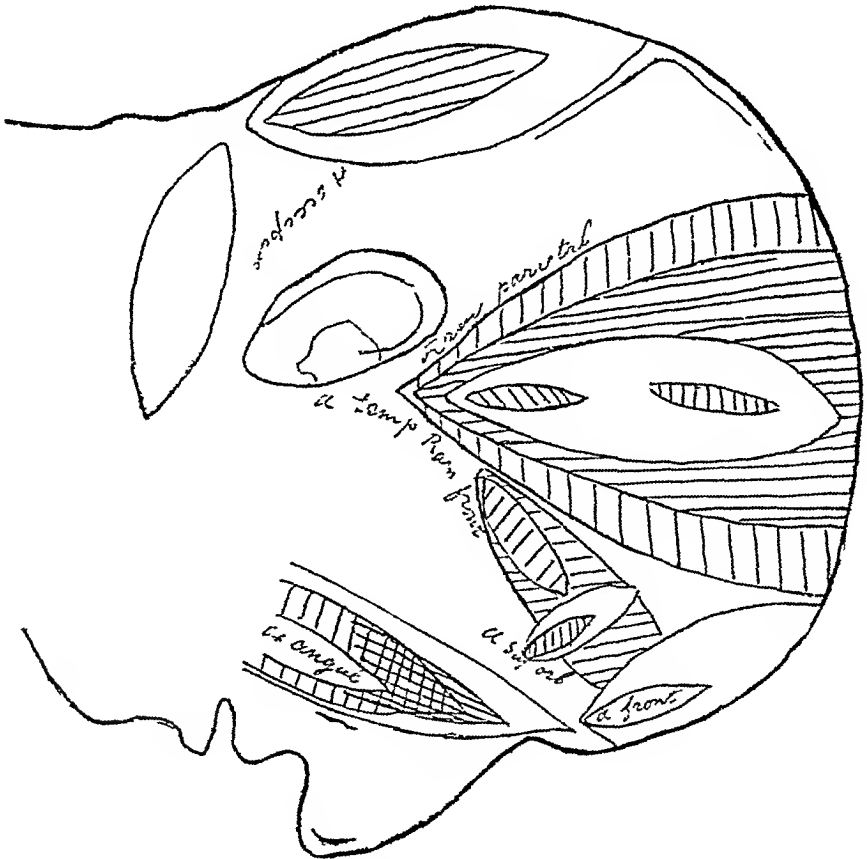


Fig 2—Outline of flap with adequate innervation, lymph, and arterial supply



other point, the importance of which cannot be over-estimated, is the complete immobility of the surroundings of the wound. Any movement will serve to press germs deeper into the interior, besides causing microscopical tears in the healing tissues.

The "biological or artery flaps" are designed on Figs 1 and 2. Figure 1 shows the position of the arteries generally used. There also exist others which are not shown in the drawing and may be used for skin flaps.

All arteries, always accompanied by veins and nerves, that lie close to them, are designed on this sketch, together in one line each time, that means, one line always indicates the position of the arteries, veins, and nerves together.



FIG 3—This plate which I received from the Clinic Borchardt shows badly the immense scars of the left half of the upper lip which receives hardly light.



FIG 4—This plate shows the entirely new lip.

Figure 2 indicates the different "biological or artery flaps" in accordance to their forms and size, and the places they are taken from.

Each one should be judged and comprehended according to the conformable parallel lines on every flap, and the manner in which they overlap each other. The parallel lines are to be thought to continue under the flaps, which overlap them, the larger being overlapped by the smaller in order not to be obliged to make a sketch of a head for each flap. In this manner the sketch shows how different skin flaps can be produced from different arteries. The flaps need not be of the same form as one of those we have given, but can have every particular form, if they only contain the vessels and nerves in their pedicle, and if they develop themselves in the direction of the territory of the arteries.

UPPER LIP INNERVATION AND CIRCULATION

It is clear which are the arteria temporal flaps, because they take their pedicle in front of the ear, while the arteria angularis flaps are taken between the nose and cheek, and the arteria frontal flaps above the latter and taken with their pedicles just at the inner limit of the eyebrows and taking in their flaps the skin tissue from the centre part of the forehead. Nevertheless, they can also be taken from very broad parts of the forehead, even the complete forehead. The reason is that the frontal artery is rather developed and has a great many communications with the vessels of the ramus anterior of the



Fig 5—This lip was scarred just as the lip of plate (Fig 1)

Fig 6—New lip, which is not yet finished as in the middle line had still to be cut away some hair roots

temporal artery. Even when the last artery is cut, its branches can be filled by the communications of the frontal artery. The same occurs with the veins and lymph-vessels. The arteria supra-orbitalis flaps are also shown on the sketch, taking their pedicle in the middle of the eyebrow.

The ramus anterior flaps are shown aside of the main arteria temporal flaps, taking their skin from the forehead, still in much larger dimension than are designed on the sketch and taking their pedicle as described in their text.

Besides, the arteria occipitalis flaps are shown in two directions as the two pointing upwards benefit from the main artery and the other is taken in a horizontal position at the base of the neck and benefits by a branch of the arteria occipitalis

For the upper lip the artery flaps of the main artery temporalis, the ramus anterior and the arteria angularis are most used. In rare exceptions the arteria frontalis can be used, but I cannot treat here the use of the frontal artery, in this article, for want of space. The use of the main artery is admitted only for men, on account of its hairy surface.

After my long general description, the following cases need no great explanations.

Figs 3 and 4 show the reconstruction of the whole of the upper lip by an arteria temporalis flap from the scalp. On account of the quality of the



FIG 7 shows the situation as I got the patient long after the mutilation

FIG 8—Same situation seen from side

FIG 9—Shows patient completely finished with new nose lip and cheek restoration

hair, it is not possible to restore only half the lip, although only the left half of the lip was badly scarred.

The natural line that separates in a vertical direction the left and right half of mustache was made by cutting away some roots of the hair.

Figures 5 and 6 show another patient, who was operated on in the same manner, but the natural line between right and left half was not yet established.

Figs 7, 8 and 9 show a case of heavy mutilation that I restored completely, as is shown by Fig 9, with a very good result. The nose I will not mention as I made it in using my method "The rotation of the cheek." The upper lip was restored in using the main artery temporal flap. The pedicle of all these cases was very thin and did not contain any skin tissue, so that the pedicle could remain with all the advantages as mentioned above.

Using this method it is technically easy to obtain a very good result.

UPPER LIP INNERVATION AND CIRCULATION

As regards the operation of harelip I objected, since 1913, to the results of the operations in use

It is not against the methods used in operations, but because the results were not satisfactory, more especially from one point of view, that is, you could always recognize the fact that the person operated had a harelip before, from the appearance of the drawn skin around the edges of the mouth, and the upper lip curving inwards, instead of outwards in a natural manner, what is called entropion. The tightening of the edge of the upper lip brings together the corners of the mouth, and the result is that the protruding of the under lip, called ectropion, is more pronounced. This ectropion of the under lip pronounces still more the entropion of the upper lip.

The results of such harelip operations were that these poor patients carried the mark, all through life, of having had a harelip. Therefore, for the patients it is far worse to have had a harelip before, and to show that the stigma of their birth had not been taken away. They even prefer to have the harelip operated unesthetically that leaves no mark and reminder of the old harelip, in preference to the most beautiful operations that leave the mark of it.

These people who are afflicted with a harelip feel inferior to other people, they feel ashamed, feeling that they are not complete and normal beings.

Since 1914 I have used my every effort to make it clear to the medical faculties that the principal and most important point of the operations of harelip was to take away every reminder that harelip had existed, and not to leave that drawn look so noticeable after the operation.

At the same time it was not only that there was too little flesh on the edge of the upper lip, but too much was added to the upper part of the upper lip, and there not being sufficient room for the quantity of flesh added, it puffs out between the edge of the upper lip and the nostrils and pronounces still more the entropion.

The principal point is, that there should not be too much flesh under the nostrils, but in abundance on the edge of the upper lip, that means curving out the red of the lip. I have developed this principle in my publications in 1916, "Prinzipien bei einfachen plast. Operationen des Gesichtes bei Kriegsverletzten mit Ersatz des Defektes aus unmittelbarer Wundnahe," Brun's Beiträge, Band 103, S. 519, and "Mundlippen Plastik aus der Nasolabial Gegend," Brun's Beiträge, Band 105, S. 545 and "Plastic Surgery of the Face," ANNALS OF SURGERY, vol. lxxv, p. 297, 1917, and "General Rules, etc.," Surg. Gynec. and Obstet., No. 24, p. 737, June, 1917, and "Arterio-angularis-Lappen für Oberlippenbau und deren Defekte," Brun's Beiträge, Band 116, Heft 2, S. 335, 1919 and "Typische Herbeiführung von Material bei einseitigen und doppelseitigen Hasenscharten," Archiv für Chirurg. Klin., Band 112, Heft 1, 1919.

I have observed that in the last years my point of view has been taken

up by many of the noted surgeons who have often omitted to give my name and seemed to try to make it understood that the original idea was their own

This principle of bringing the flesh to its proper place can be obtained by different methods of operations

There exist a great many different methods of operations to remove the harelip and in general it is said that the number of these methods proves that no one is quite superior or obtains easily a good result



FIG 10 shows the bad retracted position of the upper lip



FIG 11—The underlip is too much showing itself by its advanced position



FIG 12—Lip and nose have lost any character of harelip

In cases where it is not difficult almost any method will give you a good result if you realize in which manner you should employ it. It would lead the question too far were I to explain and criticize all these different methods in this article, that is entirely dedicated to "Artery flaps"

The angularis flap can help much in difficult cases of harelip operations where much flesh is lacking. In many cases the use of this "biological or artery flap," which can bring as much flesh as needed to the lip, demands often a correction operation afterwards to remove the superfluous tissue in its



FIG 13—Before operation



FIG 14—Six days after operation still covered with crusts

pedicle. The arteria angularis flap is the *only one* in which the pedicle always contains a quantity of tissue, because the artery is lying very far from the surface and it would be too unsafe to make the pedicle too thin, in preparing the artery with too little surrounding tissue

AIR EMBOLISM COMPLICATING THYROIDECTOMY

By LAWRENCE M. LARSON, M.D.

AND

MARTIN NORDLAND, M.D.

OF MINNEAPOLIS, MINN.

FROM THE DEPARTMENT OF PATHOLOGY OF THE UNIVERSITY OF MINNESOTA

Air embolism has long been recognized as a cause of death, but the literature records few cases taking place during thyroidectomy. In view of the seriousness of the complication and the lack of knowledge of the exact mechanism of death in these cases, it seems advisable to report all available cases. The following two instances of this condition were taken from the records of the Department of Pathology, University of Minnesota, in which the necropsies were done by one of us (L.M.L.).

CASE I—A woman, aged thirty-one years, was admitted to the Ashbury Hospital April 17, 1929, suffering from slight exophthalmos, moderate enlargement of the thyroid gland, and mild oedema of the ankles.

After a week of preparation in which compound solution of iodine was given orally, the patient was operated on under nitrous oxide and oxygen anaesthesia. Five minutes after the operation was started she suddenly became cyanotic and pulseless, and died.

At necropsy the incision in the neck was carried through the skin, fascia and platysma muscles. The prethyroid muscles were split longitudinally, but the thyroid apparently had not been manipulated. On removal of the gland it was found to be slightly enlarged but normal in contour. Section of the gland revealed a somewhat friable, fleshy consistence presenting the gross appearance of an exophthalmic type of goitre. The pleural cavities did not contain excess fluid, but each lung was in a state of almost complete collapse. The pericardial sac was normal. On examination of the heart *in situ*, the right ventricle was noted to be rather tense and distended, and on opening this portion of the organ a large amount of free air and frothy blood escaped. The pulmonary arteries also contained much frothy material. Air was not found in any of the systemic vessels. The remainder of the examination revealed nothing of note.

CASE II—A woman, aged fifty-eight years, was admitted to the Abbott Hospital October 14, 1928, complaining of a goitre which had been gradually enlarging for the past fifteen years, it had practically doubled in size during the last three years. She had had slight difficulty in swallowing, some dyspnoea on exertion, and occasional spells of palpitation of the heart. She had not noticed especial loss of weight. Examination was essentially negative except for a diffuse, moderate, soft enlargement of the thyroid gland.

Removal of the thyroid gland was undertaken October 15, 1928. During the operation the patient suddenly ceased breathing and died almost immediately.

At necropsy the lungs were apparently normal. When the right ventricle of the heart was opened with the organ in place, air and frothy blood under pressure gushed out and continued to froth for some time. The total amount of air was estimated as 200 cubic centimetres or more. The heart and its valves were otherwise normal. Air was not found in any of the systemic vessels and other pathological changes were not noted.

Occurrence of An Embolism—Rede,¹³ in 1667, recognized the fact that if air is administered in large quantities into the vein of an animal, death

results. He killed horses and oxen by blowing air into a cannula inserted in the external jugular vein.

The first authentic case following surgical procedures on the neck to be proved by necropsy was reported by Beauchesne² in 1818, air had been aspirated in the course of an operation for removal of a tumor of the neck. The patient collapsed and died in a few minutes. Because of the repeated occurrence of this complication, the neck has been considered as one of the areas of danger in the etiology of air embolism.⁸

Air embolism has been recorded in cases of wounds and operative procedures on the neck,⁸ in manipulation of the intracranial sinuses,¹⁵ in obstetrical cases,⁷ and following inflation of the urethra and bladder with air.¹⁰ Veins of the long bones, especially the tibia, and also of any of the subcutaneous tissues, have been the source of entry of air emboli.¹⁵ Diagnostic and therapeutic procedures on the thorax are not uncommonly complicated by fatal air embolism.¹⁴

Etiology and Pathology—Embolism during thyroidectomy can occur due to aspiration of air into the veins of the neck which have been cut at operation. The condition has been considered more likely after operation for intrathoracic goitre,⁸ because in these particular cases the veins may be torn accidentally and an opening would be less likely to be discovered. It is especially liable to occur in malignant growths of the thyroid gland, where the veins may be adherent and unable to collapse, thus facilitating aspiration of air into them. It has also been emphasized⁸ that air embolism may often develop several hours after operation, and even after the patient is up and about due to freeing of a ligature from a vein by coughing, by straining at stool, and so forth.

The quantity of air necessary for production of symptoms is variable according to most observers. Blair and McGuigan⁶ stated that the "fatal dose varies enormously with the same and different species." However, it is generally conceded that relatively large amounts are necessary to cause death. When the air emboli reach the right ventricle, arterial tension is decreased and venous tension is elevated,¹⁰ consequently handicapping and often completely inhibiting the action of both the heart and the lungs. Three possibilities have been presented as to the mechanism of death in these cases: (1) cerebral anæmia especially of the vital centres due to the presence of air emboli¹¹, (2) pulmonary suffocation following closure of the arteries of the lung by the presence of the air^{4, 16} and (3) the most likely, cardiac failure.^{12, 13} Large quantities of air in the right side of the heart are followed by a lowering of intracardiac tension so that the resistance of the pulmonary capillaries renders the heart-beat futile and consequently results in the stagnation of first the pulmonary and then the systemic circulations. Rukstinat and LeCount¹⁵ explained death in this condition as due to air in the coronary arteries. They account for the presence of air in the systemic vessels as due either to passage of the gas through the systemic arteries and capillaries or to a retrograde embolism into successively the pulmonary arteries, right

ventricle and auricle, and adjacent veins. Their findings were based on the presence of air emboli in the coronary arteries of twenty-two guinea-pigs after air under pressure had been forced into the trachea of these animals. In each instance air was found in the systemic arteries as well as a frothy bloody mixture in all chambers of the heart.

In the right ventricle air prevents proper closure of the valves on that side and a process of regurgitation takes place into the right auricle and its veins. Also, with each beat of the heart muscle the mixture of air and blood is churned back and forth in the form of a frothy material, thus no blood reaches the left ventricle and the entire circulation, both systemic and pulmonary, becomes stagnant and finally ceases, rapidly resulting in death.

Symptoms and Diagnosis—A fatal case of air embolism has been described as follows.^{10 15} Accompanying the entrance of air into the vein, hissing, gurgling sounds, or coarse râles, are heard, respirations are accelerated, arterial blood pressure falls, the patient in turn becomes dyspnoëic, cyanotic and comatose, and death takes place almost immediately. If less air is aspirated, the symptoms progress more slowly. The patient complains of dyspnoea, nausea, acute epigastric and precordial pain, and becomes faint, restless and frightened, the eyes are fixed and the pupils are dilated, respirations cease and the patient goes into coma, often terminated by convulsions. However, the phenomena of air embolism are not necessarily fatal, and the amount of air which is capable of producing symptoms is not definitely known. Most authors agree that small quantities of air may be introduced into the vascular system, causing slight or only transitory symptoms, no doubt due to absorption of the air by the blood and the tissues. Auscultation of the heart during the time when air is present intracardially reveals a bruit, due to the churning of air in the chambers of the right side of the heart.^{10 16} In Trubshaw's¹⁰ case, after urethroscopical examination and urethral inflation with air, the patient passed through a stage of great restlessness, cyanosis and unconsciousness, but about an hour later after stimulation, the patient regained his senses and completely recovered in several days.

In some experimental work by one of us (M. N.) it was shown there is a definite decreased resistance of the heart to air embolism in hyperthyroidism and this susceptibility becomes progressively greater with increasing toxicity of the individual. Correlating this experimental work with the pathological findings in the two cases here described, it seems there is no doubt of an increased sensitiveness to air embolism in patients with hyperthyroidism. It has also been further emphasized¹² that in neck surgery, especially thyroidectomy, the veins caudal to the field of operation frequently do not undergo complete collapse after division because of their oblique passage through the fascia, a condition which would prevent total collapse of these veins after they have been severed. It is readily conceivable that these patent veins can draw into the circulation by suction a sufficient quantity of air to cause fatal results. It is true that the chances of a process such as this

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causing death are very small indeed, yet the condition occurs frequently enough so that great care should be exercised in its prevention

Treatment—The best form of treatment is prophylaxis. It is strongly advisable to ligate securely any vessels of size before they are divided, and at the completion of the operation it is important to have the patient cough or strain so that bleeding points may be detected and secured. After embolism of air has taken place, artificial respiration and cardiac stimulation with digitalis or caffeine is indicated. The use of epinephrine administered directly into the heart is no doubt of considerable aid. As indicated in experimental work it is theoretically possible to aspirate air from the right ventricle and this procedure when followed by intracardial injection of epinephrine should be the treatment of choice. The prognosis depends directly upon the amount of air aspirated.

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MALIGNANT NEOPLASMS OF THE THYROID GLAND

BY BERNARD F SCHREINER, M D , AND WALTER T MURPHY, M D

OF BUFFALO, N Y

FROM THE NEW YORK STATE INSTITUTE FOR THE STUDY OF MALIGNANT DISEASE

MALIGNANT disease of the thyroid gland is, relatively speaking an uncommon disease. During a period of twenty years, forty-two cases of this type of neoplasm have been recorded at the State Institute for the Study of Malignant Disease. During this same period 11,212 malignancies have been recorded. This makes the incidence of malignant neoplasm of the thyroid gland 0.37 per cent.

Incidence—Berard and Dunet¹ decided that the actual frequency of malignant thyroid neoplasms is unknown because of its difficult recognition. They state that the frequency in goitrous regions is 2.5 per cent to 4 per cent of all malignant growths, while in non-goitrous regions it is 0.4 per cent to 0.5 per cent. Toland² states the incidence of thyroid malignancies is as high as 6.75 per cent, Kocher (quoted by Toland²) 7.45 per cent, Wilson³ 3.5 per cent, Collier⁴ 4 per cent, De Courcy⁵ 1.75 per cent, and Balfour⁶ 1.19 per cent.

In diseased thyroids in the Great Lakes basin Collier⁴ found the incidence of malignancy to be 1.2 per cent to 2.7 per cent. Clute⁷ says that, at the Lahey Clinic between 1916 and 1930, there were 187 cases of thyroid malignancy in 6,535 patients operated on for thyroid disease. De Courcy⁵ concluded that cancer is found in 0.7 per cent of all thyroid gland cases examined and from 1.3 per cent to 2 per cent of all operated goitre cases. Balfour⁶ found 103 cases of malignancy in 6,359 goitres exclusive of exophthalmic goitres (1.6 per cent). Speese and Brown's⁸ percentage of malignancy in goitres was 4.6 per cent, Simpson's⁹, 4 per cent of the pathological material received at this Institute.

Age—Berard and Dunet¹ report that most of their thyroid malignancies occurred between the ages of forty years and sixty years. Early cases in the literature include those of Berard¹⁰ in eighteen- and twenty-four-year-old females, of Xenia Wissmer-Kovarsky¹¹ in twenty- and twenty-seven-year-old females, of Wilson's¹² in a twenty-eight-year-old female, of Muller¹³ in an eighteen-year-old male of B. Hughes¹⁴ who described a papillary carcinoma in a thirteen-year-old female. Meleney¹⁵ reported a malignant papillary tumor in a seventeen-year-old boy. Among 112 malignant growths in persons under twenty-six years of age occurring at the Mayo Clinic during a period of ten years, Fowler¹⁶ found seven thyroid cases proven pathologically. Clute and Smith¹⁷ reported as youngest a girl of twenty years. Zahn¹⁸ reported an osteochondrosarcoma of the thyroid in a fetus. Demme¹⁹ described a sarcoma of the thyroid in a six-year-old child, and Berry,²⁰ a round-cell sarcoma in a boy of three years.

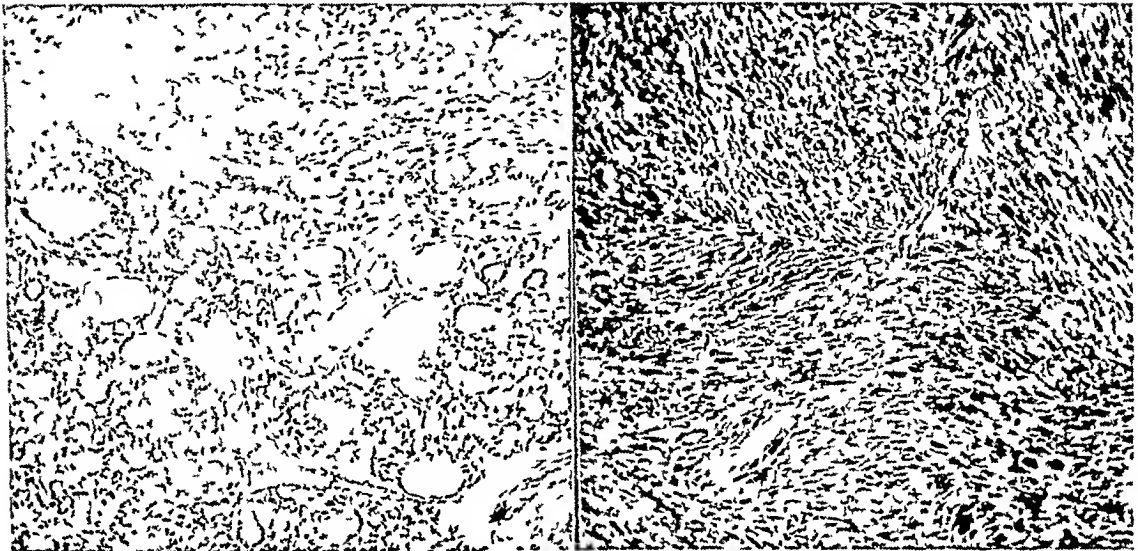
The age incidence of the patients with malignant thyroids in this institute was thus

20-29	30-39	40-49	50-59	60-69	70-79	80-89
1	6	8	9	7	10	1
Average age—52.6 years						

Sex—Recent figures show that there are more malignant neoplasms of the thyroid in females

MALIGNANT NEOPLASMS OF THE THYROID GLAND

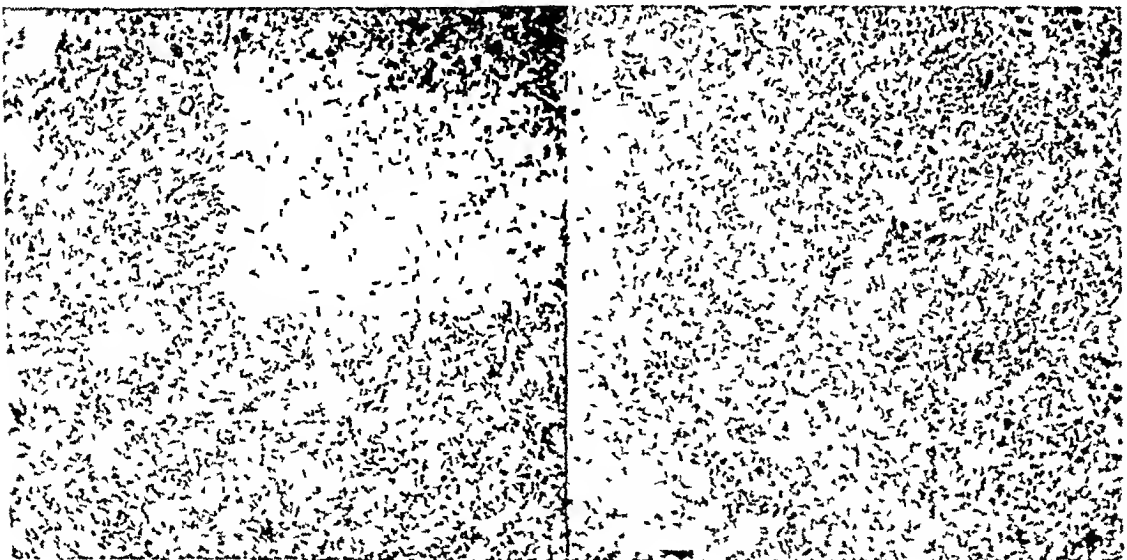
Author	Per Cent Females	Per Cent Males
Muller and Speese ²¹	60	40
Levinson ²²	51 4	48 6
Portman ²³	65	35
Coller ⁴	72 2	27 8
Wilson ³	69	31
This institute	69	31



A

B

FIG. 1—(Case 13828) Fifty eight year old male. Admitted December 29, 1930. History of unilateral goitre for thirty years. Operation, right lobe removed, August 1, 1930. Adenoma. Wound reopened November 1, 1930, tissue removed for examination—inflammatory tissue. Treatment Radium pack, 28,000 millicuries hours. Died May 14, 1931. Autopsy. Spindle cell sarcoma of the thyroid gland and acute glomerular nephritis. (A)—Adenoma at operation. (B)—Spindle cell sarcoma at autopsy.



A

B

FIG. 2—(Case 6048) Forty six year old female. Admitted December 29, 1919. History of bilateral goitre for six months. Decompression operation. Biopsy showed lymphosarcoma. Treatment Medium voltage X-ray. Patient still alive and clinically well. (A) and (B)—Lymphosarcoma with cells within blood vessel in B.

Most authorities have found the sex goitre ratio to be six to eight cases in females for one case in males. Tinker²⁴ gives eight to one, and Boothley (quoted by Lissner²⁵) reports a sex incidence in exophthalmic goitre of 82 per cent in women and 18 per cent in men. Considering the relatively low incidence of goitre among males, it is apparent that malignancies of the thyroid are more likely to develop in the male than the female, as the ratio of six or eight females to one male having goitre is not maintained but is more nearly 2:2 females to one male having malignancy of the thyroid.

Pathology—Ehrhardt (quoted by Crotti²⁹) defined malignant tumors of the thyroid gland as any intra- or extra-capsular tumor growth whose elements

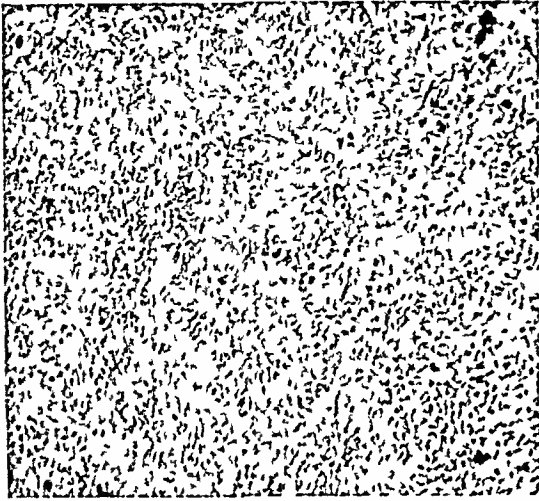


FIG. 3—(Case 11122) (Fifty year old female
Admitted June 18, 1928 History of unilateral
goitre for four months Thyroidectomy May 23
1928 carcinoma Treatment High voltage X ray
Died December 17, 1928 Round cell carcinoma
showing in places morphology resembling sarcomatous
structure

invade the capsule, encroach upon the neighboring tissues, and cause metastasis.

These tumors are developed from the epithelium—carcinomata, and from the connective tissue—sarcomata. Both have a peculiar tendency to penetrate the walls of blood-vessels, chiefly veins. Graham²⁶ said this invasion of blood-vessels by the tumor cells was the one reliable sign of malignancy, while Simpson²⁷ claims that it is wrong to place the entire emphasis of malignancy on vascular invasion. Crotti²⁸ says that it is not uncommon, at operations of cases which clinically seem to be most favorable, to find the thyroid im-

veins thrombosed and already invaded by the tumor.

Ehrhardt believes that a diagnosis between a benign growth and an early malignancy is often very difficult. Inflammation, cystic formations, calcification, hæmorrhages, necrosis, and cicatrices, combined with physiological changes in the thyroid gland, bring about alteration in the appearance of individual epithelial cells and stroma with inclusion of gland cells and acini with the resultant picture of an invasive growth. The thyroid gland does not lose its normal function because of malignant degeneration.

The epithelial malignant growths of the thyroid admitted to this institute were pathologically of two types, (1) carcinoma, and (2) adeno-carcinoma. The sarcomata consisted of spindle and lympho varieties.

Under carcinoma were grouped those cases which showed large or small groups of atypical cells of an alveolar nature and little or no colloid. Masses of deeply staining cells filling up alveoli and invading the stroma and capsule with an absence of colloid give a more typical epithelial neoplastic picture. In other areas alveoli may be more intact. The cells in the diffuse growths

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may be of different sizes, large, small, or fusiform In many cases, a picture resembling a connective-tissue neoplasm is found Adeno-carcinoma, according to Ewing,²⁹ cannot be distinctly separated

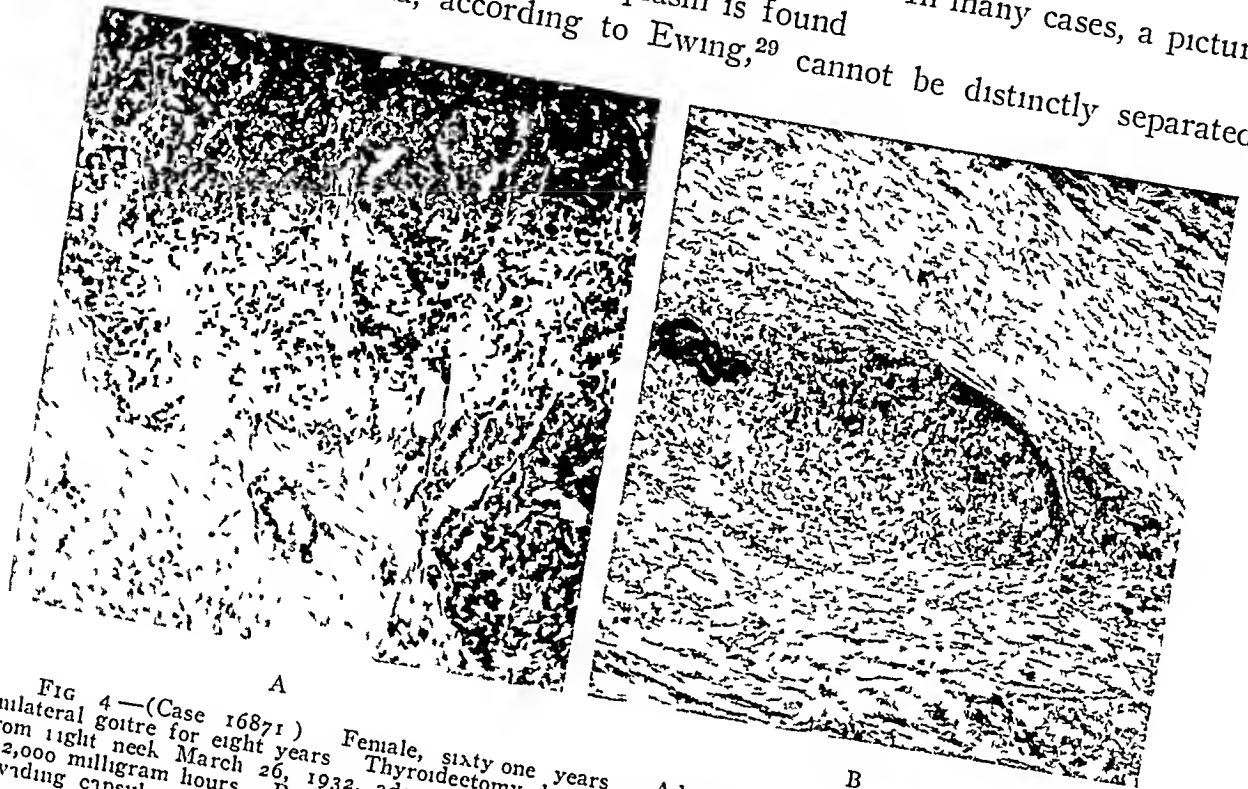


FIG 4—(Case 16871) Female, sixty one years Admitted October 26, 1932 History of unilateral goitre for eight years Thyroidectomy done October, 1928, adeno carcinoma Node removed from right neck March 26, 1932, adeno carcinoma Treatment Radium packs in this institute for 112,000 milligram hours Patient alive and improved (A)—Adeno carcinoma (B)—Malignant cells invading capsule and blood vessels

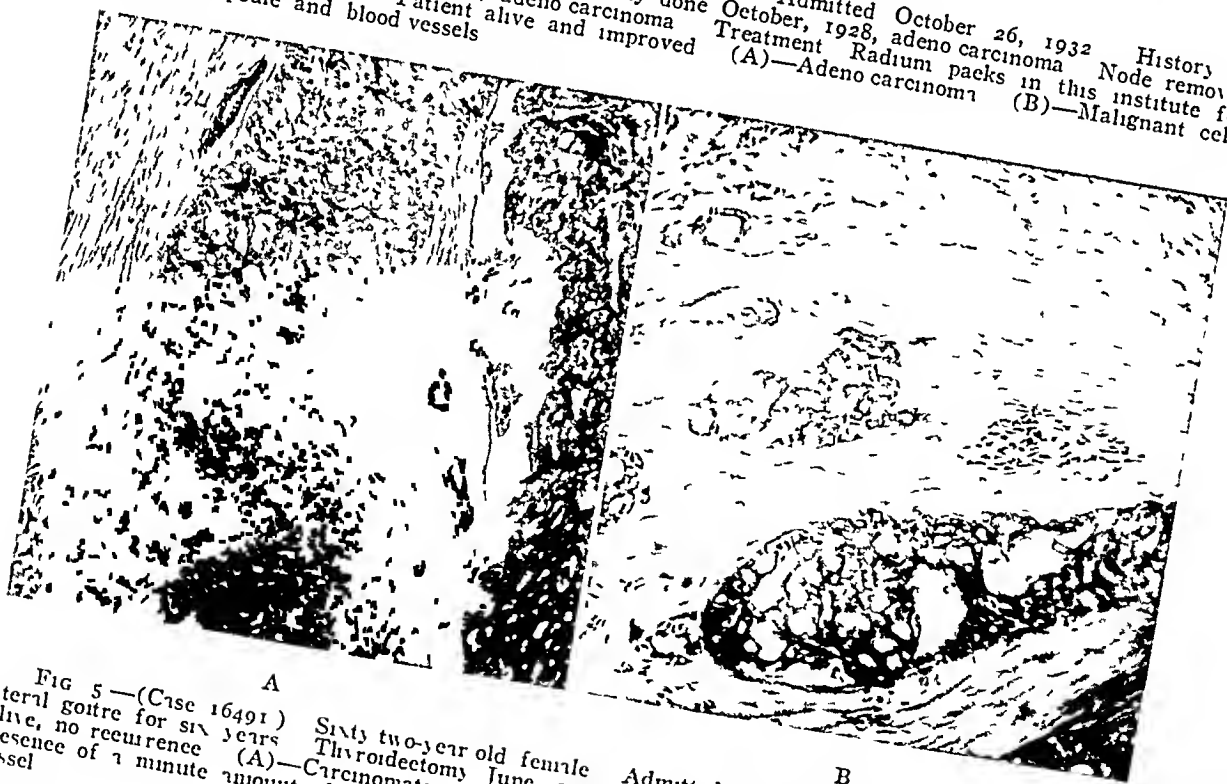


FIG 5—(Case 16491) Sixty two-year old female Admitted August 22, 1932 History of unilateral goitre for six years Thyroidectomy June, 1932, carcinoma Treatment High voltage X ray Alive, no recurrence (A)—Carcinomatous formation with a slight amount of alveolar structure and presence of a minute amount of colloid secretion (B)—Malignant cells invading capsule and blood vessel from carcinoma Papillary cyst adeno-carcinoma is included under this group As a rule adeno-carcinoma presents a more vascular tumor with the presence of old or new hemorrhages The epithelial cells, which nearly always show

distinct alveoli structure, are found to lie in intimate relation to the vascular endothelium. In more atypical cases groups of epithelial cells group themselves about blood-vessels in a convoluted manner and may even give a sarcomatous picture in those cases where the alveolar tendency is reduced to a minimum and the individual epithelial cells are transformed into bizarre shapes in intimate relation to blood spaces (Ewing²⁰)

Sarcoma of the thyroid occurs usually between the ages of fifty and sixty and grows extremely rapidly. Many cases described as sarcoma are undoubtedly carcinomas in which the epithelial cells have undergone morphological changes resembling connective-tissue elements.

Our spindle-cell sarcoma presented a massed and confluent growth of hyperchromatic spindle-shaped cells with the absence of any alveoli.

One lymphosarcoma gave a picture of invasion and obliteration of alveolar epithelial structures by immature lymphatic cells. It is quite apparent from the history, physical examination and pathological picture that this tumor arose in the thyroid gland.

The other lymphosarcoma was a large mass occupying the thyroid region. This was biopsied only and the biopsy did not show any of the thyroid tissue.

A history of pre-existing goitre is present in the majority of malignant growths of the thyroid. Figures from the past reports are

Author	Per Cent. of Goitre
Coller ¹ (1929)	75
Clute and Smith ³⁰ (1929)	94.4
Speese and Brown ⁸ (1921)	78.5
Delore ³¹ (1910)	82
Muller and Speese ²¹ (1906)	59

All of our cases gave a history of thyroid enlargement previous to consulting a physician. Some of these goitres were undoubtedly due to malignant changes taking place in the gland, while most were benign growths. Foetal adenomas are the benign growths which are most frequently found in association with thyroid neoplasms (Graham,³² 1925). Pemberton³³ (1928) found one exophthalmic goitre in 276 cancers of the thyroid, and Coller¹ (1929) found one in ninety. Other goitres which are seldom associated with cancer are the diffuse thyroid gland hypertrophy without adenomas and the unilocular cyst of large size (Stout³⁴).

In our cases the average goitre history was 4.97 years, the shortest duration being one month and the longest, forty years.

Treatment—Treatment of the forty-two cases of malignant disease of the thyroid was carried out by means of irradiation, either X-ray alone, radium alone, or a combination of X-ray and radium. This treatment was given both to those patients who had had radical surgery before admission and to those who had had no treatment before admission. The factors of the treatment and the results obtained are given in the following paragraphs (See table, also).

Four of the forty-two cases which were admitted prior to 1921 were

MALIGNANT NEOPLASMS OF THE THYROID GLAND

[illegible]

treated by means of medium-voltage X-ray with aluminum filter. With the exception of the patient who was suffering from lymphosarcoma and who is alive and well fifteen years after treatment, this type of treatment proved to be inadequate.

Another patient, admitted before 1921, was treated with a surface application of 50 milligrams of radium for a total of 1,600 milligram hours. This also is regarded as having been inadequate treatment.

Thirty-six of the cases were treated since 1921 by means of high-voltage X-ray and radium packs.

The factors of the high-voltage X-ray were 200,000 volts, milliamperes varying from 1921 to 1926 from 4 to 30 milliamperes, distance from 50 to 80 centimetres, size of field varying according to the size of the tumor. Full erythema doses were given to the skin through one or more ports of entry. These treatments were given in cycles, the highest number of cycles being four.

Radium packs prior to 1930 were used at 6 centimetres distance with a filter of 2 millimetres of brass, 0.5 millimetre of silver, 1 millimetre of aluminum, and 1 centimetre of rubber, size of field 6.5 by 7.5 centimetres, in doses of 6,000 to 8,000 milligram hours per field.

Since 1930 the four-gram radium element pack was used at 10 centimetres distance filtered through 1 millimetre of platinum, 1.5 millimetres of steel, with a secondary filter of 0.5 millimetre of copper and 1 millimetre of aluminum. The dosage at 10 centimetres was from 50,000 to 60,000 milligram hours.

In one instance, the case of spindle-cell sarcoma, radium tubes filtered through 1 millimetre of platinum were inserted into each lateral lobe and left there for a total of 800 milligram hours. In addition to that he also was given radium pack for 24,000 milligram hours through two fields at 6 centimetres distance.

One case was not treated.

Results of Treatment—Of the forty-two cases, one case was not treated. Eighteen had been operated radically. Upon admission, twelve were treated with X-ray only, four with radium only, and two with X-ray and radium combined.

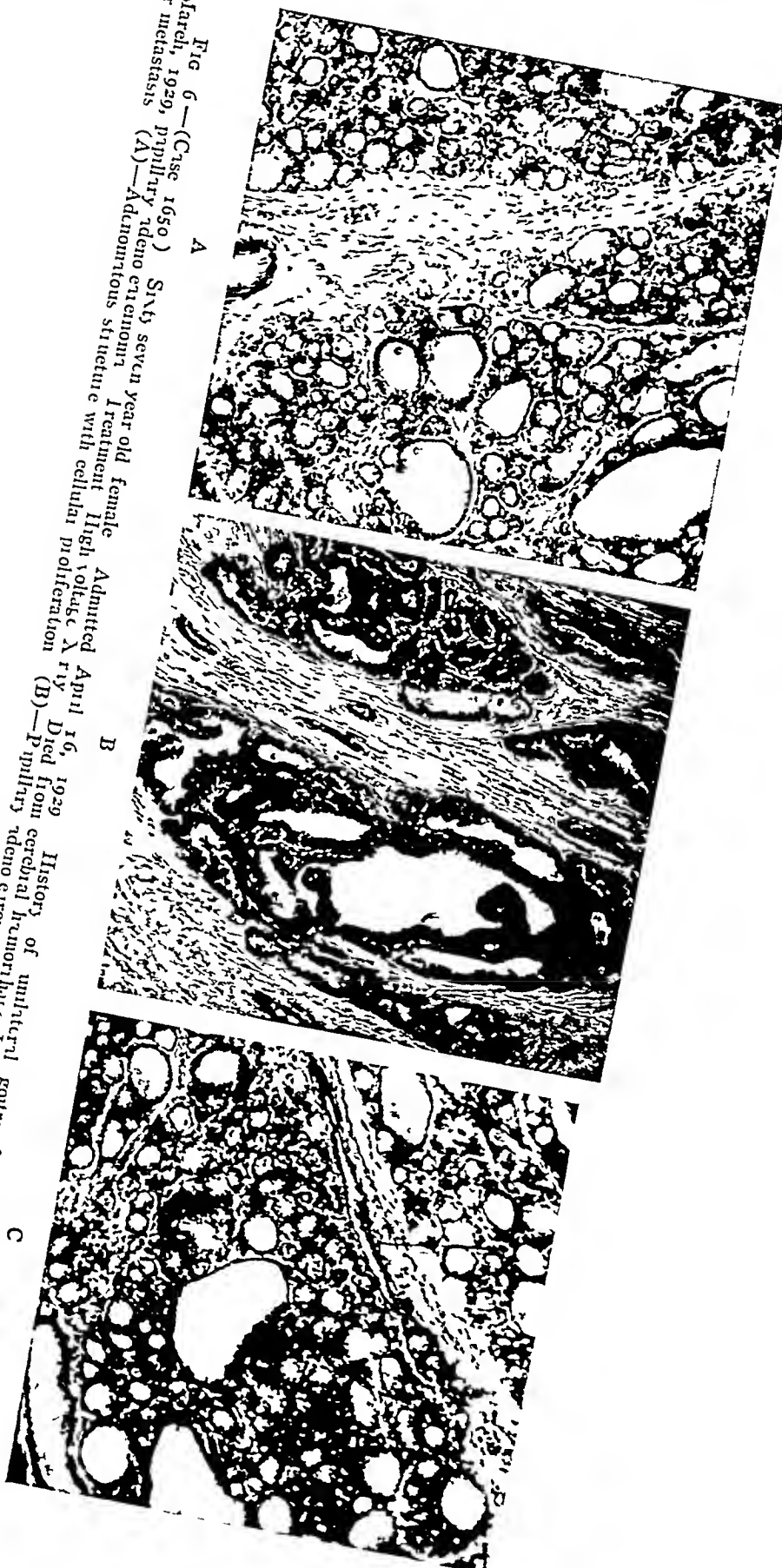
Three of those treated with X-ray alone are alive—two for between one and two years, and one between four and five years. One patient died from a cerebral hæmorrhage after being free from the disease for over two years. The others died from the disease, seven in less than a year, and two between three and four years.

Two of the post-operative cases treated with radium alone are alive—one for a year, and one for between one and two years. One of these, a spindle-cell sarcoma, died in six months; the other, a carcinoma, died from the disease in between two and three years.

The two cases treated with a combination of radium and X-ray following

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Fig 6—(Case 1650) Sixty seven year old female Admitted April 16, 1929 History of unilateral goitre for seven years Thyroidectomy March, 1929, papillary adenocarcinoma Treatment High voltage X ray Died from cerebral hemorrhage January 25, 1932 No evidence of recurrent or metastasis (A)—Adenomatous structure with cellular proliferation (B)—Papillary adenocarcinomatous structure (C)—Adeno carcinomatous structure



operation died from the disease, one in between eight and nine months, and one between three and four years

Five other cases which were inoperable had biopsies performed. One of these, a lymphosarcoma, was decompressed by Dr. George Crile to relieve pressure and then was treated here with X-ray. This patient is alive fifteen years after admission. The four other biopsies proved to be carcinoma. These four patients were treated, two with X-ray, one with radium, and one with a combination of radium and X-ray, and died from the disease two in one to two months, one in three to four years, and one between eight and nine years.

In the eighteen remaining cases the disease was far advanced so no biopsies were made. Fourteen patients had X-ray alone. Eleven of these died from the disease in less than a year, one is living at the end of a year, and two died from the disease in between one and two years. Three had radium packs alone, these died, one in between one and two months, one between six and seven months, and one after four years. The remaining case was treated with a combination of radium and X-ray and died from the disease in between one and two months.

Of the forty-two cases, five died at the institute and autopsies were obtained. Three of these had had radical operation and irradiation. One had had biopsy only and irradiation, and one was not treated. All showed widespread generalized metastases.

CONCLUSIONS—(1) Malignant disease of the thyroid gland is relatively uncommon, representing 37 per cent of all malignancies seen at the institute.

(2) In our experience it has been a fatal disease with few exceptions.

(3) It would seem that the only curative procedure would be early operation followed by irradiation.

(4) When a clinical diagnosis of malignant disease of the thyroid is possible, the case is usually hopeless and irradiation is only palliative.

(5) One case of lymphosarcoma of the thyroid is hereby reported alive and well for fifteen years after treatment.

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EXPERIMENTAL AND CLINICAL STUDIES OF THE RELATIONSHIP OF THYROID DISEASE AND PANCREATIC FUNCTION II*†

BY J WILLIAM HINTON, M D , AND PAUL C MORTON, M D

AND CARNES WEEKS, M D

OF NEW YORK, N Y

THE controversies one hears over the rôle of iodine as an etiological factor in thyroid disease, and its indication and contra-indication as a therapeutic agent, have led us to undertake the following study to see if we could assist in clarifying the action of iodine in the thyroid gland and give a more intelligent understanding of its indications therapeutically

In reviewing the history of iodine it is seen that it was discovered in 1811 by Courtois¹ and it was first used in the treatment of goitre by Comdet,² in 1820 Provost,¹³ in 1849, carried on investigations which led to the theory that there was a relation between iodine deficiency and the incidence of goitre, and his work led to the extensive use of iodized salt by the French until 1860 (xxx) in an attempt to prevent the occurrence of goitre in school children in France In 1860, Rilliet¹⁵ described toxic symptoms which followed overdosage with iodine and denounced the procedure before the French Academy of Medicine From his unfavorable report the use of iodine in thyroid diseases fell into disfavor and for the next thirty to forty years other theories received considerable attention

One should remember that the thyroid gland by dried weight contains 3 per cent of iodine and the fact that of this percentage 65 per cent is in the form of thyroxine led one of us (J S D, Jr) to suggest the following investigation of the mode of action of iodine in the gland It became obvious that there must be two different angles to the approach of iodine deficiency, one being the thyroid gland and the other the source of supply of the substance, from which the active principle is formed, namely, protein metabolism, which in its process of hydrolysis by trypsin is broken down into amino-acids and finally tyrosine, which is the substance from which thyroxine is actually derived The theoretical relationship of amino-acid metabolism to thyroid disease was given in an earlier paper by us⁸ For the details of this consideration the reader is referred to our first paper Sweet,¹⁷ in 1915, published the results of his observations on ligation of the pancreatic ducts in dogs in which they developed translucent and transparent thyroids, and the iodine determination of the gland revealed a very marked increase It was then concluded that the external secretion of the pancreas, trypsin, which was excluded from the intestinal tract, prevented the proteins from being hydro-

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lized into amino-acids and finally tyrosine, and deprived the thyroid of the substance from which its active principle thyroxine is derived, and as a result colloid goitres would develop and the iodine content of the gland be increased

Kendall⁹ had isolated the active principle of the thyroid in 1915 and found it to be thyroxine, and Harington and Barger,⁴ in 1927, synthesized thyroxine. The illustration of the amino-acid tyrosine to thyroxine is illustrated in Fig 2. Their work, with the observations of Sweet,¹⁷ would lead one to believe that excluding trypsin from the intestinal tract, which in turn interferes with

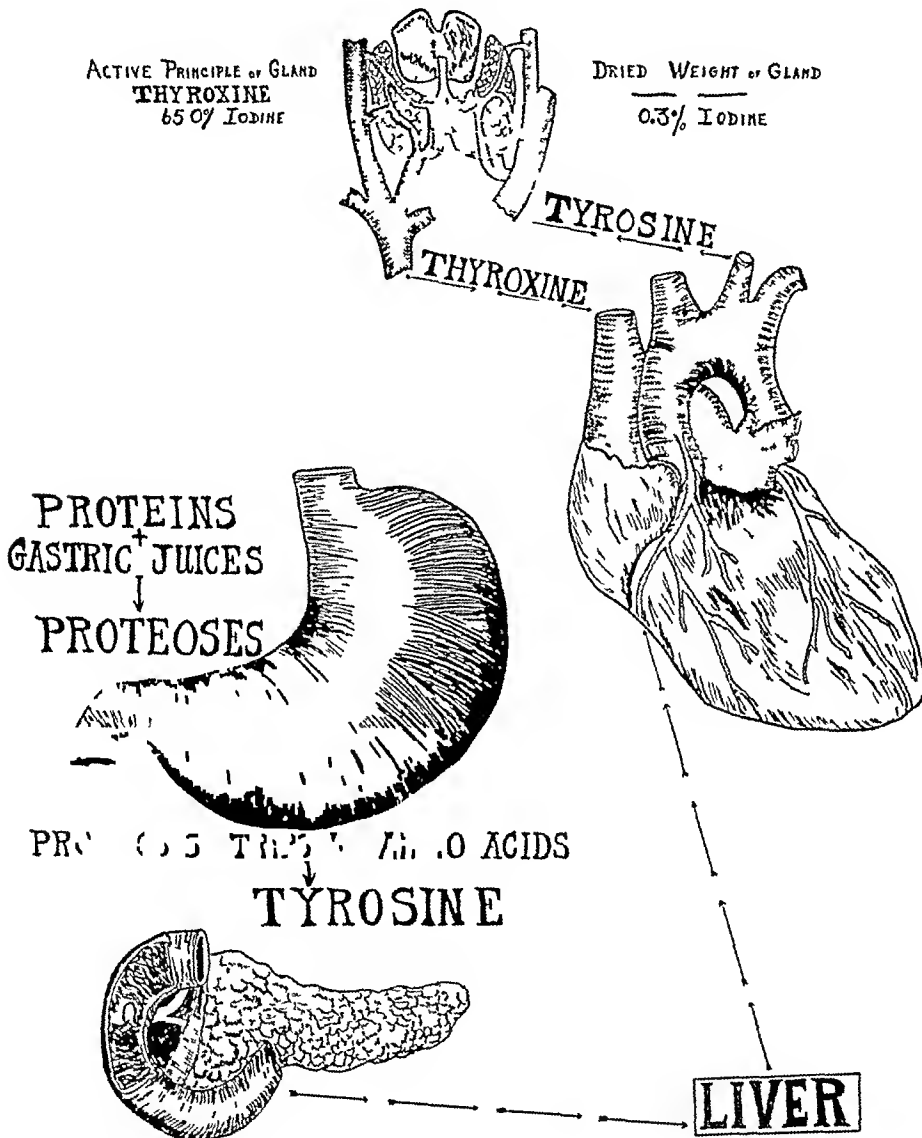


FIG 1

protein metabolism, would be a definite factor in the production of thyroid disturbances. The schematic relation of the thyroid and pancreas is illustrated in Fig 1.

It seems well established that iodine plays a large part in the development of an abnormally functioning thyroid. Marine¹¹ showed in 1908 that iodine when administered to dogs would produce rapid involution. Plummer¹² applied this to man in 1921 and accomplished similar results in hyperplastic or exophthalmic goitres. He maintained that iodine was beneficial in this type but injurious in the nodular or adenomatous goitres with hyper-

thyroidism as the secretions were different Graham, in 1925,³ showed iodine was beneficial in either type of hyperthyroidism

Formation of Thyroxine from Tyrosine

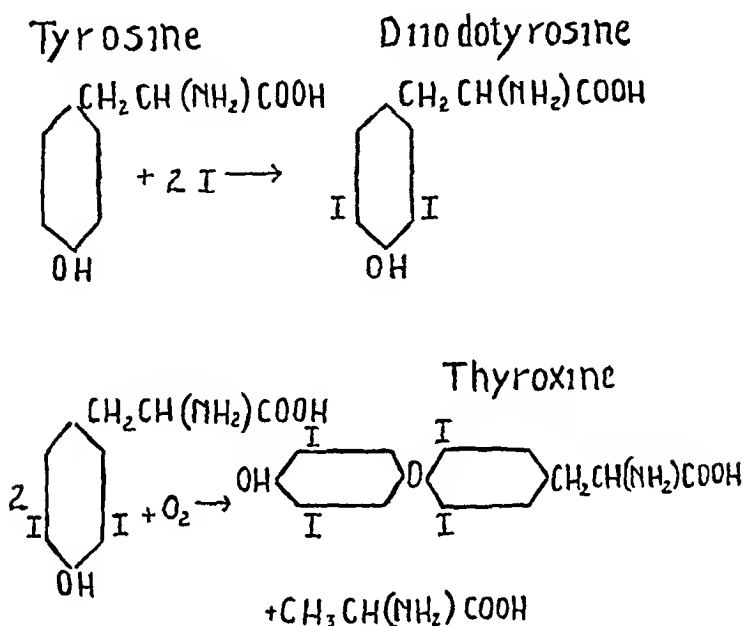


FIG 2

If tyrosine is removed from the thyroid, then it is to be expected that the iodine content of the gland will rise because there would be less tyrosine present to mobilize the iodine in the form of thyroxine, hence the iodine would be deposited in the gland and a colloid type of goitre would be developed

Formation of Tyramine from Tyrosine

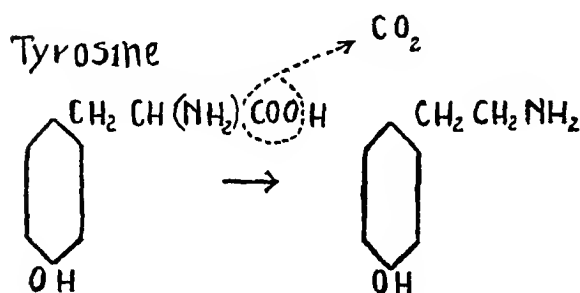


FIG 3

toxic goitre Tyramine can be formed from tyrosine by enzyme or bacterial action as shown in Fig 3 The rôle of infection and intestinal disturbances has frequently been discussed with respect to diseases of the thyroid MacCarrison¹⁰ has been one of the chief exponents of this idea The factors responsible for thyroid changes, in his opinion, are likely to be vitamin deficiency and gastro-intestinal infection

Fig 4—Illustrates ligating main pancreatic duct

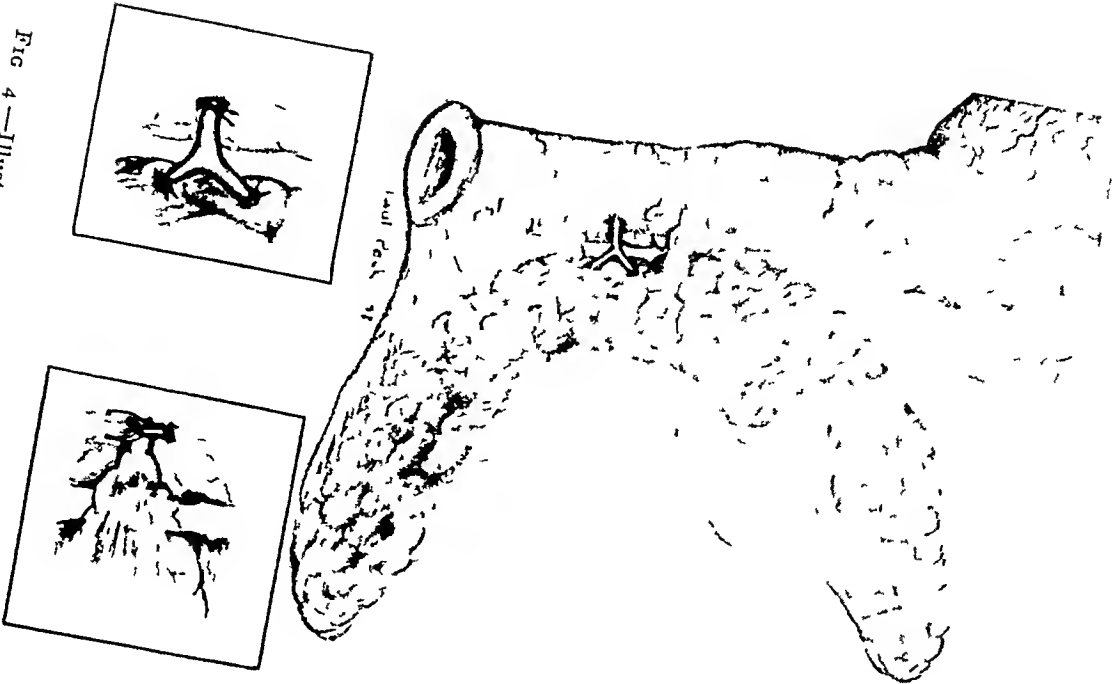
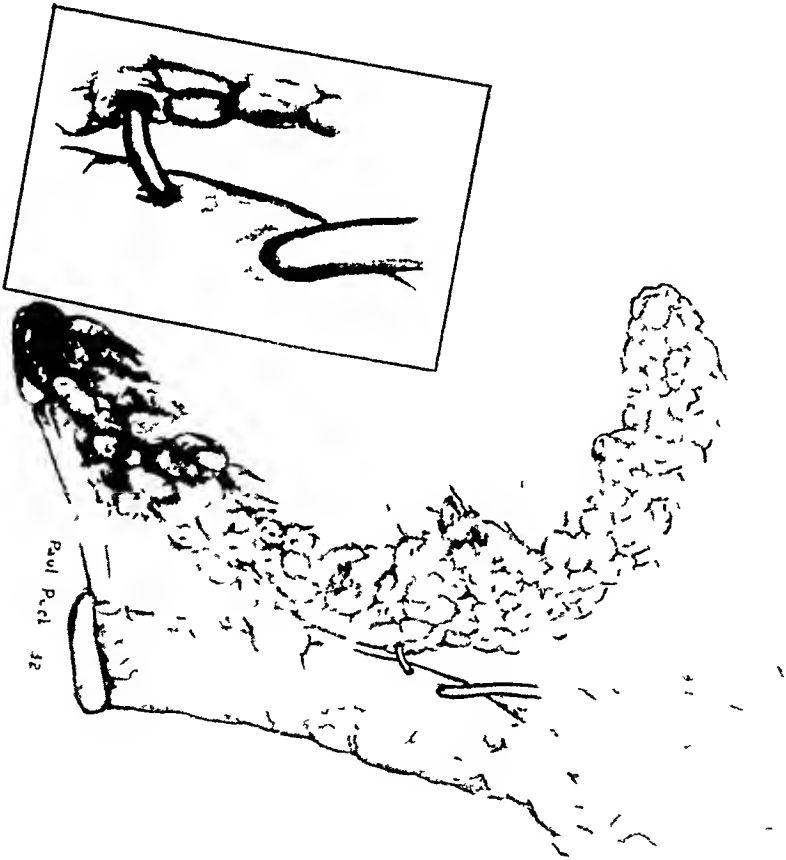


Fig 5—Illustrates ligating small pancreatic duct



Recently one of us⁷ has noticed a number of patients complaining of epigastric pain and indigestion whose metabolic rates were below the normal range. No cause for the pain other than the hypothyroidism could be found. After the administration of thyroxine and thyroid extract these patients recovered.

In an effort to substantiate this idea, that the cause of a certain part of thyroid disease is due to a disturbance at the source of supply of the components of the thyroxine molecule, we have performed a number of experiments on dogs and have also studied the blood of 100 cases of various types of thyroid disease for their tyrosine and tyramine content. Since our work was started we have carried out experiments on sixty-five dogs which we wish to report at this time.

(1) To determine if colloid goitre can be produced in dogs by ligation of pancreatic ducts, and if the condition can be produced more rapidly by the feeding of iodine.

(2) To determine if the feeding of tyrosine and pancreatin, or the administration of thyroxine or tyramine, will prevent the formation of such a goitre.

(3) To determine whether the tyramine or tyrosine content is increased in the blood of patients suffering from toxic thyroid disease.

EXPERIMENTS

The experiments have been done in the Department of Experimental Surgery of Cornell University Medical College, through the courtesy of Doctor Sweet, and under his supervision. We wish to express our gratitude at this time to Dr. Joshua E. Sweet, Professor of Experimental Surgery of Cornell Medical College, for the privilege of carrying on this work.

There are certain technical difficulties encountered in ligating the pancreatic ducts which should be emphasized. The main duct divides about one centimetre after leaving the intestine in a "Y" shape, if one is not careful to find both branches, one branch of the duct will be ligated and the other overlooked, a result which is particularly probable if the division is nearer to the intestinal wall than that usually found. The ducts are illustrated in Figs. 4 and 5, with the method of ligation as carried out in our experiments, and Fig. 6 shows the pancreas atrophied after four weeks. Although Doctor Sweet demonstrated the method of ligation at the beginning of the work, it was necessary to discard the first three dogs because only part of the duct had been ligated, or the duct had regenerated, but if one is careful to follow the technic as illustrated the ducts will remain permanently occluded.

When the dogs are autopsied the duodenum should be opened and the pancreatic ducts carefully probed to see that the ducts have remained permanently occluded. Even with experienced operators, in this type of work, one cannot overemphasize the importance of following out exact details.

In our work last year the skin was painted with 3½ per cent iodine but the iodine determination on glands with the pancreatic ducts occluded was greatly increased, while in cases with the ducts not occluded there was no increase of iodine, so we concluded the absorption from the skin did not influence our results. The more recent animals have had their skin washed with 65 per cent alcohol, and no iodine has been used.

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Before considering the results of the animal experiments we would like to discuss the histological picture of the normal human thyroid. From the teaching of histologists we have been led to believe the normal human gland presents a rather uniform picture, but due to the difference of opinion among pathologists as to a workable diagnosis of pathological material, it led us to undertake a histological study of the normal gland with the finding of a marked variation in people of the same relative age. A report⁶ was made on this work two years ago and we are now making additional studies on normal humans including the iodine determinations of the gland, and this will be reported at a later date, but there is a fairly wide range of iodine which varies from 50 to over 200 milligrams per 100 grams of dried weight of gland.

The microphotographs will show the marked variation in the human thyroid. Fig 7 is a male, stillbirth. This section reveals no acini, but masses of epithelial cells, while Fig 8, which is from a male infant eighteen months old, dying from miliary tuberculosis, reveals some acini but mostly undifferentiated epithelial cells. Fig 9 is a male, thirty-two years, dying from liquor poisoning. The gland is made up of large acini with flat cells and abundant colloid. Fig 10 is a male twenty-nine years, dying from stab wounds of the abdomen. This gland contains abundant epithelial cells and very little colloid. Fig 11 is from a male seventy-two years, dying from senility and chronic nephritis. Note the abundance of epithelial cells and the small amount of colloid. Fig 12 is from a female, fifteen years, dying from acute dilatation of the heart. The gland contains large acini with flat epithelial cells and abundant colloid. Fig 13 is a male, twenty-three years, dying from gunshot wounds. The gland has very few acini and practically no colloid but contains numerous epithelial cells.

In view of this marked variation in the histological picture of human glands we are better prepared to understand the results of our animal experiments. It is important to emphasize the marked variation in the histological picture of the dogs' thyroid in different localities, and for that reason we have taken a section from the thyroid, or removed one lobe, when performing the pancreatic operation, so as to have the normal gland to compare with the thyroid after the experimental period.

We first present sections from a dog with the pancreatic ducts ligated. Fig 14 was taken at the original operation. The iodine determination on this gland was insufficient to estimate accurately. Fig 15 was taken at the time of death, 109 days later. It can be seen that the colloid has increased and the iodine determination on this gland revealed 653 milligrams. This we attribute to storage of iodine due to the inability to manufacture thyroxine in the thyroid.

The next animal was fed fifteen grains of pancreatin a day to supply trypsin and to see if we could prevent a colloid goitre from forming after ligating the ducts. Fig 16

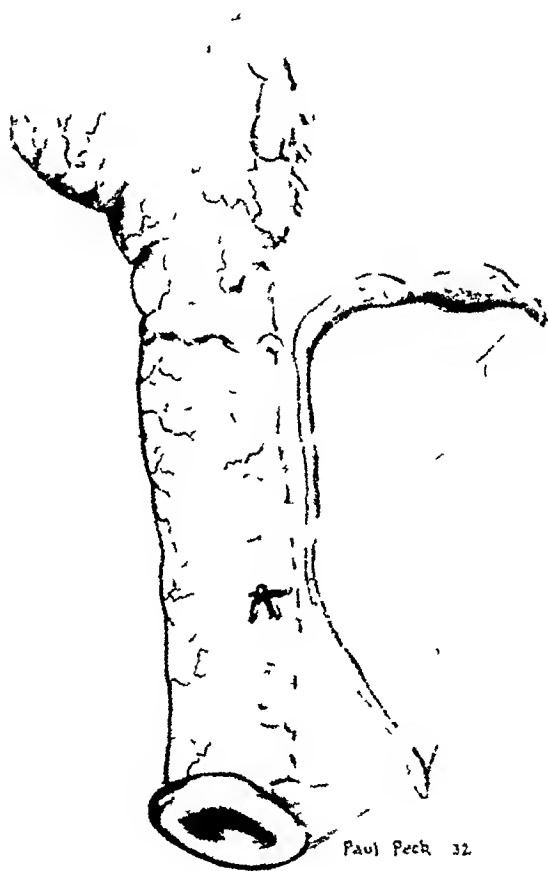


FIG 6—Appearance of pancreas in a stage of atrophy six weeks later

was taken at the original operation and the iodine on this specimen was too small to estimate with accuracy. Fig 17 shows slight colloid changes eighty-eight days later at which time the animal had lost 35 per cent of his body weight. The iodine on this



FIG 7—Male stillbirth

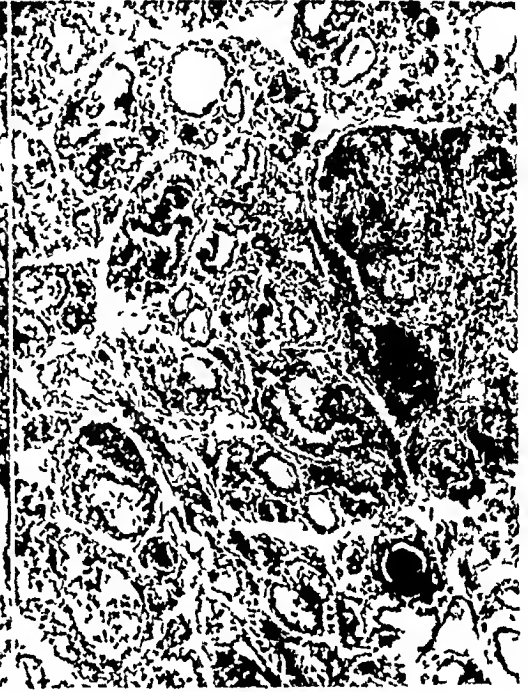


FIG 8—Female, eighteen months, died miliary tuberculosis



FIG 9—Male, thirty two, died alcoholic poisoning



FIG 10—Male, twenty nine, died gunshot wounds

specimen was 714 milligrams. The pancreatin may have had some influence in preventing a colloid goitre but it was very slight.

The use of thyroxine in animals with the pancreatic ducts ligated is very interesting

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The dogs can be carried for indefinite periods with the administration of thyroxine, and if our conception of the formation of thyroxine from protein metabolism is correct, then this is easily understood, because we are only keeping the animal in balance. The



FIG 11—Male, seventy-two, died senility and chronic nephritis



FIG 12—Female, fifteen months, died decompensated heart

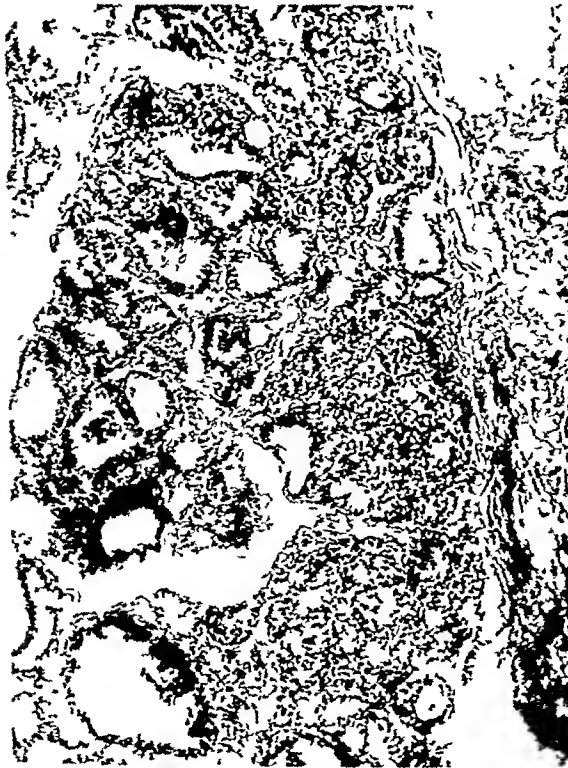


FIG 13—Male, twenty-three, gunshot wounds



FIG 14—Normal dog's thyroid removed at time of ligating pancreatic ducts

amount that is needed is difficult to determine but I am sure we have given too large doses. This animal had five ampules a week or five milligrams. From the work of Thompson, McLellan, Thompson and Dickie¹⁸ 1.5 to 2 milligrams of thyroxine at five-day

intervals is sufficient for humans with metabolic rates of minus 30 to 40. From their work it would seem that one milligram at weekly intervals would be sufficient in dogs. These sections are very interesting because Fig 18 shows a rather active gland with



FIG 15 — Appearance of gland one hundred and nine days later



FIG 16 — Normal thyroid removed at time of ligation of pancreatic ducts

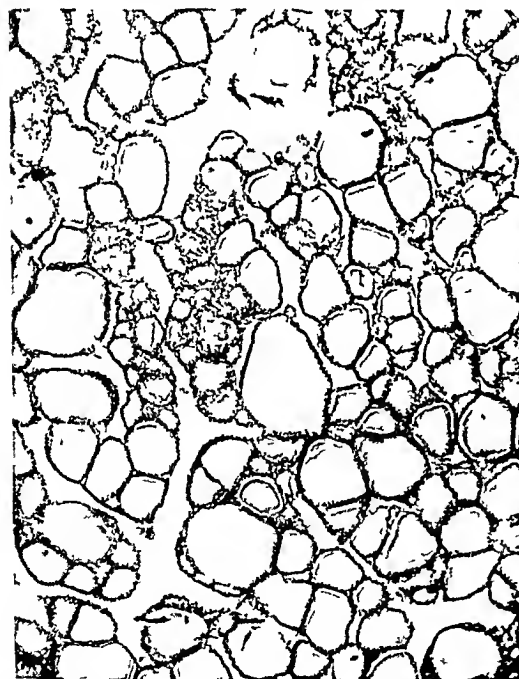


FIG 17 — Appearance of gland eighty eight days later after receiving pancreaticin medication



FIG 18 — Gland removed at original operation

numerous epithelial cells and some colloid. The iodine was thirty-three milligrams. In Fig 19, which was thirty-three days later, there is very little colloid and the epithelial cells apparently in a state of inactivity which we attribute to the function of the gland

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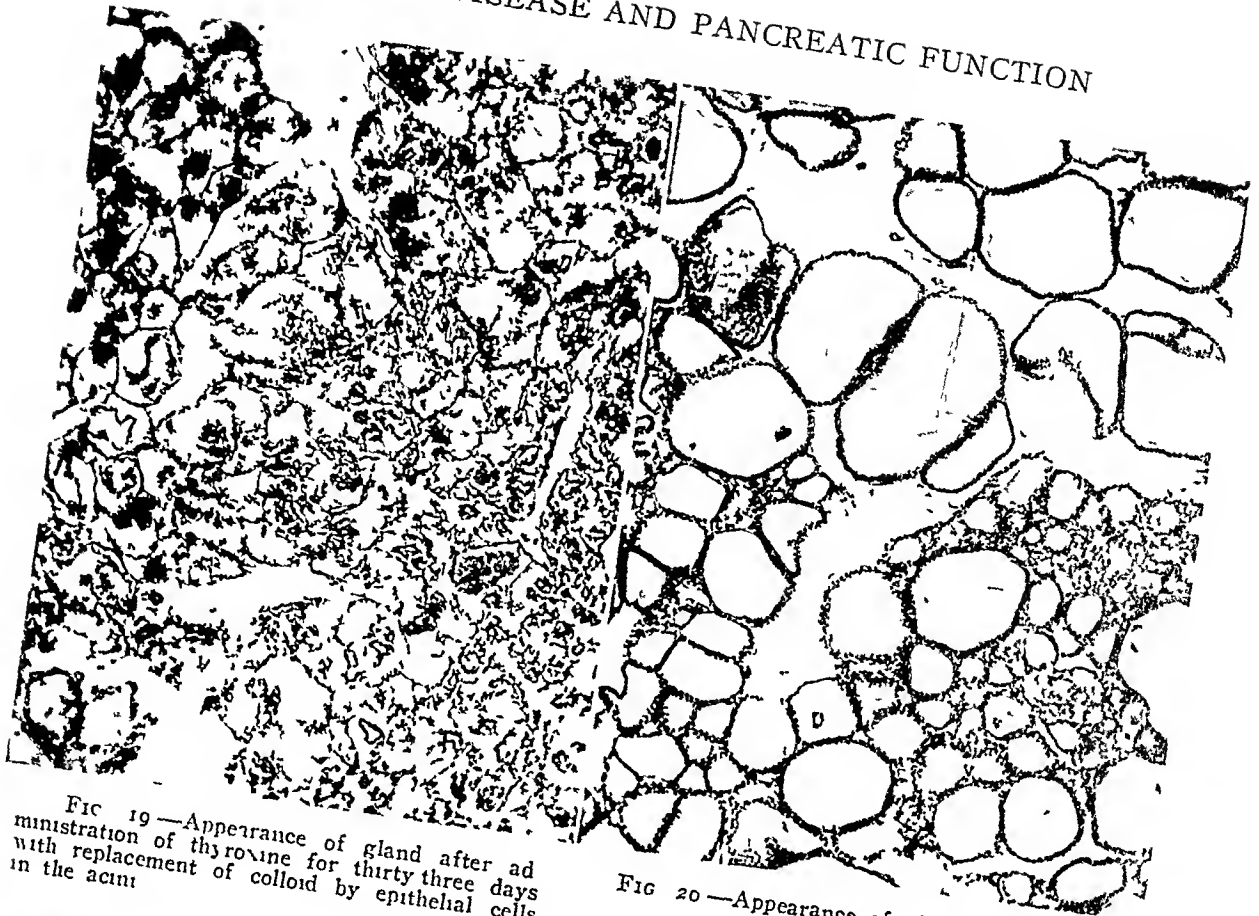


FIG 19—Appearance of gland after administration of thyroxine for thirty three days with replacement of colloid by epithelial cells in the acini

FIG 20—Appearance of gland at original operation

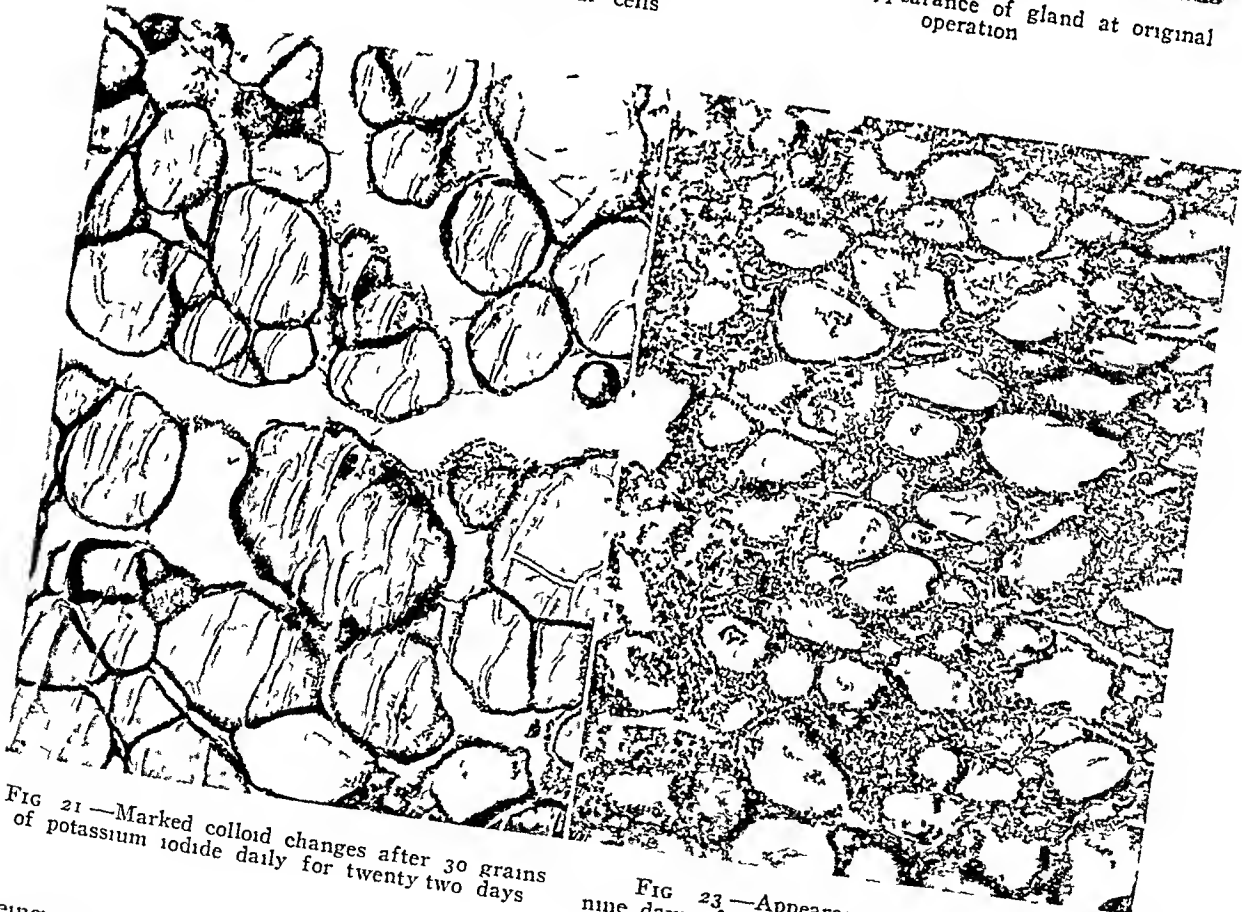


FIG 21—Marked colloid changes after 30 grains of potassium iodide daily for twenty two days

FIG 23—Appearance of gland at death nine days after original operation and the animal receiving duodotyrosine with replacement of colloid, and acini containing some epithelial cells

being entirely removed by administering large doses of thyroxine. The iodine in the gland was 395 milligrams, which can be understood from the addition of the iodine in the thyroxine

The administration of potassium iodide is not tolerated by dogs with the pancreatic ducts ligated and it kills them in two to four weeks. The gland already has an excessive amount of iodine due to the fact thyroxine cannot be formed and the administration of potassium iodide by mouth is more than the animals can tolerate. Fig 20 was the original gland and it contained twenty-four milligrams of iodine. At the time of death twenty-two days later there were colloid changes which are seen in Fig 21, and the iodine was 150 milligrams.

Dogs that are given either tyramine, or di-iodotyrosine, usually die within seven to fourteen days. Fig 22 shows some colloid and a moderate number of epithelial cells. The iodine was twenty-five milligrams. At the time of death, nine days later, after administering ten milligrams of di-iodotyrosine, every other day, very little colloid remained in the acini and they resembled somewhat the thyroxine dogs, as can be seen by comparing Fig 22 with Fig 19. The iodine was 411 milligrams. Harrington and Randall's,⁵ in 1929, stated that 50 per cent of the iodine in the thyroid was in the form

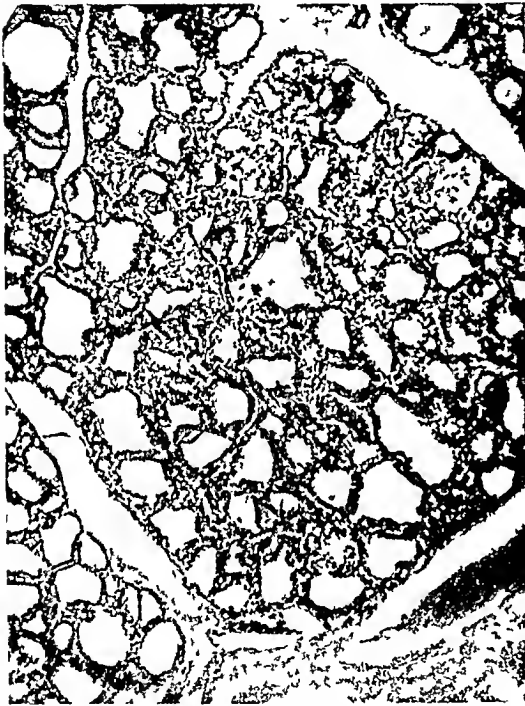


FIG 22—Appearance of gland at original operation

of di-iodotyrosine and the remainder in the form of thyroxine. If this is so, it might explain the toxic effects of di-iodotyrosine when administered intravenously. Salter, Leman and Means¹⁰ maintain that all the iodine in the thyroid is in a combination that is physiologically equivalent to thyroxine. It can be seen that we can only give our results and not explain them.

That our original hypothesis is not entirely correct, however, was shown in our first paper. The addition of tyrosine to the diet of the operated dogs would not prolong life. Nor did we find an appreciable drop in the blood-tyrosine content of the animals. Rapport¹⁴ has recently shown that when tyrosine is added to the blood of dogs it disappears almost immediately but only a very small part is taken up by the thyroid.

The tyrosine and tyramine content of the blood of 100 people have been studied. Thirteen of these were normal, five had other diseases than thyroid disturbances, and eighty-two had some type of thyroid disorder. At the present writing we are not prepared to report fully on this phase of the work, however, the analytical findings to date appear to possess some significance in differentiation of the hyperthyroid from normal and hypothyroid subjects. For thirteen normal individuals, a mean figure for the total of tyrosine and tyramine of the blood was found to be 4.52 milligrams per 100 cubic centimetres between extremes of 3.9 and 6.4 milligrams. The mean figures for tyrosine and tyramine was 3.62 and 0.89, respectively. For eight subjects whose basal metabolic rate varied from 2 to 19 per cent below the average normal, the mean figure for the total was 4.80 milligrams, for tyro-

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sine 3.91 milligrams, and for tyramine 0.89 milligrams per 100 cubic centimetres. Four patients with thyroid disease whose basal metabolic rates varied from the average normal to 15 per cent above the average normal gave a mean figure for the total of 4.95 milligrams, for tyrosine of 4.57 and tyramine 0.37 per 100 cubic centimetres. Twenty-six patients with thyroid disease whose basal metabolism ranged from 16 to 90 per cent above the average normal, and who had received no iodine therapy, as far as we know, presented a mean figure for the total 7.42 milligrams, for tyrosine of 5.38 and for tyramine of 1.92 milligrams per 100 cubic centimetres. Seven patients had been on iodine therapy for ten days to eighteen months, gave an average

TABLE I
Recovery of Tyramine Added to Blood

Constituent	Control	Added ml per 100 ml	Theoretical mg per 100 ml	Found mg per 100 ml	Error Per Cent
Total	5.98		20.98	20.54	-3.0
Tyrosine	5.64		5.64	5.98	+6.0
Tyramine	0.34	15.0	15.34	14.56	-6.0
Total	6.13		13.63	13.68	+0.4
Tyrosine	5.64		5.64	5.74	+1.0
Tyramine	0.49	7.5	7.99	7.94	-1.0
Total	6.90		10.65	10.86	+1.0
Tyrosine	5.95		5.95	6.40	+7.5
Tyramine	0.95	3.75	4.70	4.46	-5.1
Total	6.90	7.50	14.40	14.08	-2
Tyrosine	5.95	3.75	9.70	10.80	+10
Tyramine	0.95	3.75	4.70	3.78	-24
Total	6.90	7.50	14.40	14.08	-2
Tyrosine	5.95	3.75	9.70	9.42	-3
Tyramine	0.95	3.75	4.70	4.66	-1
Total	6.90		21.90	22.22	+1.0
Tyrosine	5.95	15	20.95	21.27	+1.0
Tyramine	0.95		0.95	0.95	
Total	6.90		14.40	15.49	+7.5
Tyrosine	5.95	7.5	13.45	14.54	+8.1
Tyramine	0.95		0.95	0.95	
Total	6.90		14.40	14.08	-3.0
Tyrosine	5.95	7.5	13.45	13.03	-4.0
Tyramine	0.95		0.95	0.95	
Total	6.90		10.65	10.64	-1.0
Tyrosine	5.95	3.75	9.70	9.69	-1.0
Tyramine	0.95		0.95	0.95	

figure for their total of 5.11, for tyrosine 4.04 and for tyramine 1.07 milligrams per 100 cubic centimetres

The tyrosine and tyramine determinations were done under the supervision of Dr John A Killian of the New York Post-Graduate Hospital. His modification of the Hanke and Koessler¹⁰ method was used. This method is not accurate but we believe may give some indication of the amount of tyrosine and tyramine in the blood. Table I gives an idea of the accuracy of the method by adding tyrosine and tyramine to the blood and recovering some after determining the normal tyrosine and tyramine content. Table II gives the results in control cases and patients with thyroid disease.

TABLE II

Tyrosine and Tyramine of Blood of Controls and of Patients with Thyroid II Disease

Number of Subjects	B M R Per Cent of Average Normal	Tyrosine mg	Tyramine per 100 ml	Total of Blood
13	Controls	3.62 ± 0.61	0.89 ± 0.73	4.52 ± 0.59
8	-20 to -19.0	3.91 ± 0.88	0.88 ± 0.9	4.80 ± 1.1
4	0 to +15.0	4.57 ± 0.625	0.37 ± 0.27	4.95 ± 0.60
26 No iodine therapy	+16 to +90	5.38 ± 1.55	1.92 ± 1.39	7.42 ± 1.95
7 Iodine therapy	+23 to +88	4.04 ± 0.91	1.07 ± 0.78	5.11 ± 0.90

A summary of all available analytical data at present indicates that the upper normal level for both tyrosine and tyramine in human blood is 5.0 milligrams per 100 cubic centimetres. For the seventeen subjects, including controls and cases of thyroid disease whose basal metabolic rate was less than 15 per cent above the average normal, 71 per cent had less than 5.0 milligrams of tyrosine and tyramine in the blood. Of the thirty-three subjects whose basal metabolic rate exceeded plus 15 per cent, 79 per cent had more than 5.0 milligrams of tyrosine and tyramine per 100 cubic centimetres of blood, varying from 5.0 to 19.2 milligrams per 100 cubic centimetres. Patients on iodine therapy exhibit lower values for this total. If the subjects receiving iodine are excluded from this group, 85 per cent have total values above 5.0 per 100 cubic centimetres.*

* We wish to thank the Medical Services of St. Luke's Hospital for the use of human material.

Diet in itself affects the content of these substances in the blood only slightly. After iodine administration there is apparently a drop of tyrosine and tyramine in the blood, particularly of the latter. The same drop usually follows operation. The sicker the patient the higher the tyramine and tyrosine content. No normal individuals have been found to have a tyramine content greater than 1 milligram per 100 cubic centimetres of blood while the case of a patient suffering with hyperthyroidism is found to rise as high as 7.5 milligrams. It has not been found to be as high as this in other types of disease.

Comment—To draw definite conclusions from our work at this time would be premature and misleading. It can be seen from the animal experiments as well as from the clinical cases, that there is a definite inter-relation between the thyroid gland and the digestive processes. The clinical course of the animal is of considerable interest, as it was seen that dogs with their pancreatic ducts ligated and without medicine, develop colloid goitres with high iodine content in the gland, and progressively lose weight and usually die within six to twelve weeks, but some live a longer period.

The administration of potassium iodide, tyramine or di-iodotyrosine will result in death in animals that have their pancreatic ducts ligated within ten days to three weeks, whereas animals without their ducts ligated tolerate these medicines without ill effects. Dogs that are given thyroxine, intravenously, after ligation of the pancreatic ducts, maintain their weight and clinically are in a good state of health over a long period of time, and rarely die if thyroxine is administered regularly.

From clinical observations of typical cases of hypothyroidism it is found they respond much more satisfactorily to the intravenous use of thyroxine, with thyroid by mouth, than do cases that are receiving thyroid without intravenous use of thyroxine. In the cases of undersecreting thyroids with abdominal pain, it is rarely possible to relieve their symptoms by oral administration of thyroid, but they respond most favorably to thyroxine, intravenously, and thyroid by mouth.

The peptic ulcers that we have treated have gotten quite marked relief symptomatically as a result of thyroxine and thyroid therapy. It is not claimed that this is a cure for ulcers but from the limited experience we have had clinically it has proven quite satisfactory. This may be explained on the basis of a chronic pancreatitis, associated with the ulcer. In the Gastro-Enterological Clinic of the Fourth Medical and Surgical Divisions at Bellevue Hospital we have found that chronic pancreatitis is the only real indication for surgical intervention in ulcer patients and we feel that there is a pancreatic involvement in a much higher per cent of ulcer patients than has generally been admitted.

We are continuing this work as there seems to be some clinical application and we do not wish to make definite claims at this time but it seems worth while to record our findings.

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STAB WOUNDS OF THE HEART

BY EDWIN G. RAMSDELL, M.D.

OF NEW YORK, N. Y.

REPORT OF A CASE SUCCESSFULLY SUTURED AND A RÉSUMÉ
OF 428 CASES REPORTED TO JANUARY 1, 1932

IN MAY 1932, I presented before the Surgical Section of the New York Academy of Medicine a case of stab wound of the heart, successfully sutured. This surgical emergency is met with so infrequently in the routine practice, and so few cases have been reported by American surgeons, it seems worth while to bring the statistics up to date.

Since the original work by Peck, several of the important compilations of these cases have appeared in the *ANNALS OF SURGERY*. I submit now for publication in the *ANNALS OF SURGERY* the attached case report and statistical resume of fifty cases, including my own, appearing in the literature since Schoenfeld's list in 1928.

November 3, 1931, a well-developed colored man, aged forty-one years, was stabbed in the fifth left interspace, about two centimetres to the inner side of the nipple. The blade of a large "scout knife" was used. Immediately following the injury he pursued his assailant the distance of a city block, and, unable to overtake him, walked back to the house, entered and complained to his friends that he had been stabbed and was feeling weak. He sat down for a few minutes and then attempted to go out for the second time, when he fell to the floor unconscious. The police were called and the patient was taken to the White Plains Hospital. He was thought to be dead. He was admitted at 11:40 P.M. and in the emergency ward was given adrenalin and intravenous saline. He remained unconscious with a barely perceptible pulse which was rapid and irregular. He was bleeding moderately from an irregular wound about three centimetres long and in the fifth left interspace. It was apparent that the knife blade had passed through the fifth costal cartilage.

The diagnosis of stab wound of the heart was made and an exploratory operation undertaken forty-five minutes after his admission to the hospital. This was probably not more than one and a half hours after the injury.

The procedure was carried out under general anaesthesia. The incision was extended upward and downward from the original stab wound, the upper part paralleling the sternal margin and the lower part turned obliquely outward along the border of the eighth rib. The left pleural cavity was found opened and partially filled with blood, the left lung collapsed. In order to obtain adequate exposure as expeditiously as possible, the fourth, fifth, sixth and seventh cartilages were divided close to the sternum and an attempt made to turn them back at the costochondral junction. This was successful only with the fourth—the fifth, sixth and seventh were removed *in toto*, the fifth having been damaged by the original wound. Blood was partially evacuated from the left pleural cavity and a gauze pack inserted to facilitate exposure of the pericardium. On the upper, anterior surface of the pericardium there was at once visible a clean wound about two centimetres in length from which blood was steadily flowing. The pericardial sac was opened in its long axis and the heart exposed. *Delirium cordis* is the only term which adequately describes the heart's action—it was beating with all degrees of irregularity and tremendous rapidity. A wound in the substance of the muscle of the right ventricle was observed to be bleeding freely.

The left index finger was placed over the wound and a silk suture on a curved needle was inserted passing through the substance of the muscle. A second suture was similarly inserted and firmly tied. These two sutures seemed to control the bleeding from the heart. A quantity of blood and clots was carefully evacuated from the pericardial sac behind the heart and the pericardium closed with interrupted chromic sutures placed about one inch apart to allow for any serous discharge. The chest-wall was sutured in layers without drainage. As accurately as possible the sixth and seventh cartilages were replaced in their former positions. The fifth cartilage which had been originally damaged, was sacrificed. As the pleural cavity was being finally closed it was very interesting to see the lung expand. Heart action became regular in a few hours.

An X-ray of the chest taken on the eighth post-operative day (Fig 1), showed normal heart and lung shadows and no fluid in the pleural cavity. The wound healed



FIG 1



FIG 2

FIG 1—X-ray of patient's chest eighth post-operative day showing normal heart and lung shadows
FIG 2—Photograph of patient on nineteenth post-operative day

kindly and the patient was discharged on his nineteenth post-operative day (Fig 2). The hospital chart showed an unusually uneventful convalescence.

The man returned to his usual work of furniture and piano moving and was seen at intervals for the next few months. April 19 1932 five and one-half months after the injury an electro-cardiogram (Fig 3) was made by Dr Harold Pardee, who reported "normal sinus rhythm. Normal A-V conduction time. Neither right nor left axis deviation of the QRS group. The T wave is inverted in lead one and two and is coronary, indicating disease of the ventricular muscle."

The writer wishes to emphasize two points. One is the fact that though not frequently met with in ordinary civil practice injury to the heart should always be considered when dealing with penetrating wounds of the chest. The other that in dealing with known or expected acute traumatic injuries of the heart some type of chondroplastic flap through an intercostal incision

is to be preferred. In other types of heart surgery, as suggested by Cutler¹ in his chapter on the Surgery of the Heart and Pericardium in Dean Lewis Practice of Surgery, the sternum-splitting incision which avoids entering the pleura is advantageous. In penetrating wounds of the heart, however, in far the greater number of cases the pleural cavity has already been opened so that the chondrioplastic flap, modified to suit the individual case, gives a far more expeditious and an easier mode of approach.

As a result of the above experience interest in the subject of heart wounds was stimulated and the literature reviewed, bringing up to date a statistical résumé of the reported cases.

Dr. Rudolf Matas,² in his chapter on Surgery of the Heart and Vascu-

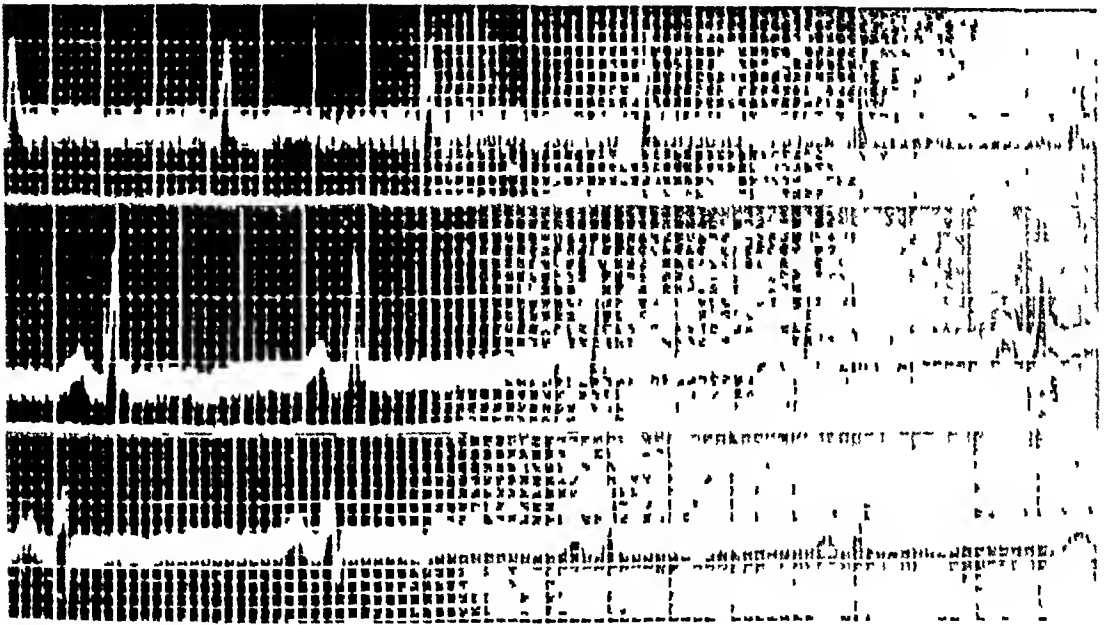


FIG. 3—Electrocardiogram taken five and a half months after accident.

lar System in Keen's Surgery, presents a most complete and interesting history of the subject. He reminds us that "The road to the heart is only two or three centimetres in length in a direct line but it has taken surgery nearly 2400 years to travel it." Another interesting resume is made by Sir Charles Ballance³ in the Bradshaw lecture on Surgery of the Heart.

Most writers agree that Cappelan,⁴ of Norway, sutured the first human heart, unsuccessfully, in 1895. In March, 1896, Farma⁵ of Rome was the second to attempt to suture a human heart. His patient also died. In September, 1896, Rehn,⁶ of Frankfurt, operated upon the third reported case and the first to recover.

In 1909, Peck,⁷ of New York, reported a successful suture of a wound of the right auricle and tabulated 160 previously reported cases of cardiac wounds treated by operation.

In 1912, Pool,⁸ of New York, reported a successful suture of the left margin of the heart and tabulated seventy-seven additional cases collected since Peck's publication.

In 1923, Smith,⁹ of Atlanta, reported two cases, one successfully and

the other unsuccessfully operated upon. He tabulated fifty-eight additional cases.

In 1927, Schoenfeld,¹⁰ of Washington, reported a successful suture of a wound of the left ventricle in a child five years old who had fallen on a pair of scissors. He adds twenty-five cases, all of which had been reported since Smith's paper.

In a careful search through the literature since Schoenfeld's publication we have been able to find fifty additional cases, including our own.

To the above may be added the fifty-eight cases mentioned by Sir Charles Ballance in the Bradshaw lecture. These are reported by him as cases occurring during the World War which were treated surgically. He does not tabulate the cases but states that there were forty-four recoveries and fourteen deaths, giving a mortality of 24.13 per cent.

Referring to the above figures it would appear that there have been reported to date 428 cases, 233 of which recovered, 195 died, the mortality being 45.56 per cent. This agrees with the observation made by Guisevas,⁴⁵ in 1929, that there had been reported 109 cases in the Russian literature, ninety Italian, eighty-three French, fifty Austrian, forty-eight American, eleven English, nine Scandinavian and three Swiss.

Other writers give a greater total number of cases, notably Dshanelidze,¹¹ who refers to "535 cases of injury of the heart treated surgically between 1896 and 1921 with 44 per cent recoveries," and Toptchibasheff,¹² who states that "over 600 cases of cardiorrhaphy have been reported in the literature." This discrepancy in numbers is undoubtedly due to a repetition of identical cases in different lists.

The following list is a resume of the cases we were able to find in the literature since the compilation made by Schoenfeld.

This list comprises fifty cases reported in the literature from all parts of the world. Out of the total number of 428 reported cases, fifty-five were operated upon in America, with thirty-nine recoveries, an American mortality of 47.2 per cent.

The approach to the heart in practically all cases was made by means of some type of osteo-plastic or chondro-plastic flap, including a varying number of ribs from the third to the seventh. In none of these cases was the sternum-splitting incision, described by Cutler,¹ employed.

REPORTS IN MEDICAL LITERATURE OF WOUND OF HEART

Collected by	Total Cases	Recovered	Died	Mortality %
Peck (1909)	160	59	101	63.13
Pool (1912)	77	42	35	45.50
Ballance (1919)	58	44	14	24.13
Smith (1923)	58	38	19	32.76
Schoenfeld (1927)	25	16	9	36.00
Ramsdell (1932)	50	33	17	34.00
Totals	428	233	195	45.56

STAB WOUNDS OF THE HEART

Cases Reported since Schoenfeld's List

LEFT VENTRICLE

Surgeon Date Pt's, Sex and Age	Etiology Location	Time before Op	Type of Operation	Drain	Complications	Result
Jones ¹³ 1923—M, 33	Stab w'd 1 vent	70 min	O F 5-6-7	?	Rt pleural effusion, collapse 1 lung	Died on table
Graves ¹⁴ 1929—M, 27	Stab w'd 1 vent	1 hr	Costostern 3-4-5	yes		Rec
Blalock ¹⁵ 1931—M, 22	Stab w'd 1 vent					Rec
Bufoini ¹⁶ 1926—M, 32	Stab w'd 1 vent		4-5	yes	Other stab w'ds hemathorax	Rec
1926—M, 20	Stab w'd 1 vent			yes	Stab w'd liver, pneumothorax	Died 30 hrs
Martinez ¹⁷ 1927—M	Stab w'd 1 vent				D T's, broncho- pneumonia, inf costal cartilage	Rec
Kisztly ¹⁸ 1931—M, 16	Stab w'd 1 vent	1 hr 15 min	O F 4-5-6	no	Pneumothorax mesenteric throm- bosis?	Rec
Stocker ¹⁹ 1931—M, 22	Gunshot w'd 1 v		O F 3-4	no	Hemathorax, w'd inf, pleural effusion	Rec
Jakob ²⁰ 1927—M	Stab w'd 1 v		O F 3-4-5-6		L pneumothorax, other injuries	Rec
Cantelmo ²¹ 1926—M, 24	Stab w'd 1 v	24 hrs	Resect 6-7	yes	Precordial em- physema, pneumo- thorax	Died 48 hrs
Sudhoff ²² 1928—M, 18	Stab w'd 1 v			no	Rt-sided emphy- sema, bronchitis	Rec
von Seeman ²³ 1929—M, 19	Stab w'd 1 v		Intercost resect 5th	no	Inj 1 pleura, pneu- mothorax, 24 hrs p-o 1 litre gas re- moved from 1 pleura positive for Frankel's bac, staph and strept	Died 96 hrs

LEFT VENTRICLE (*continued*)

Surgeon Date Pts , Sex and Age	Etiology Location	Time before Op	Type of Operation	Drain	Complications	Result
Cole ²⁴ 1927—M , 30	Stab w'd 1 v		Resect 4-5		Pericardial effusion, abscess medias- tinum, pneumonia	Rec
Allen ²⁵ 1928—M , 32	Stab w'd 1 vent				Partial collapse 1 lung	Died
Doughty ²⁶ 1929—M , 25	Stab w'd 1 vent	2 hrs	Resect 3-4-5-6	yes	Autopsy-clot about chordae tendinae	Died
Moritsch ²⁴ 1930—M , 22	Gunshot w'd 1 v		Resect 3rd O F 4-5	no	Pneumothorax, hemathorax, atelectasis 1 lung	Died 96 hrs
1930—M , 27	Stab w'd 1 vent		Rib retract		1 pneumothorax, hemathorax	Rec
Toptchibasheff ¹² 1931—M , 16	Stab w'd 1 vent	7 min	Resect 4-5	yes	1 pneumothorax, lung sutured, hydrothorax drained, fistula chest-wall	Died 3 mos
1931—M , 26	Stab w'd 1 vent	6 hrs	Rib resect	no	Hemathorax, w'd 1 lung sutured	Died 5 hrs

STAB WOUNDS OF THE HEART

RIGHT VENTRICLE

Surgeon Date Pts , Sex and Age	Etiology Location	Time before Op	Type of Operation	Drain	Complications	Result
Engel ²⁸ 1923—M , 17	Stab w'd r vent	several hrs	Kochers flap	yes	Pneumothorax	Rec
Schoenbauer ²⁹ 1924—M , 24	Stab w'd r vent	several hrs	Resect 3-4-5		Stab w'd conus pulm artery, em- bolism pulm artery	Died 67 hrs
Naegeli ³⁰ 1928—M , 23	Stab w'd r vent	several hrs	Resect 3-4-5	no	Pneumonia	Rec
Martinez ¹⁷ 1927—M , 27	Stab w'd r vent					Rec
Luccarelli ³¹ 1927—F , 14	Gunshot w'd r v	44 hrs	Resect 3-4-5	yes	Empyema	Rec
Pfeiffer ³² 1928—M , 14	Gunshot w'd r v			yes	Hemothorax	Rec
Blackburn ³³ 1924—M , 22	Stab w'd r v		O F			Rec
Cox ³⁴ 1928—M , 26	Gunshot w'd r v	3 hrs	O F			Died 48 hrs
Doughty ²⁶ 1929—M , 25	Stab w'd r v	1 ¼ hrs	O F 3-4-5	yes		Rec
Sherard, ³⁵ Stevens & Hutchins 1928—F , 27	Stab w'd r v	20 min	Rib resect	yes	Pleural effusion drained posteriorly	Rec
Nissen ³⁶ 1930—M , 25	Stab w'd r v	25 min	Resect 4-5 and sternum		Rt empyema	Rec
Ramsdell 1932—M , 41	Stab w'd r v	1 ½ hrs	Chondro- plastic 4-5-6-7	no		Rec

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LEFT AURICLE

Surgeon Date Pts , Sex and Age	Etiology Location	Time before Op	Type of Operation	Drain	Complications	Result
Simconi ³⁷ 1925—M , 36	Stab w'd l auricle	10 hrs ?	Resect 4-5	yes	Massive pleural effusion	Died 9 hrs
Meier ³⁸ 1930—M , 30	Gunshot w'd l a and apex	2 hrs	Rib resect	yes	W'd of pleura su- tured Autopsy showed chr endo- carditis, sub-dia- phragmatic hemor- rhage	Died 36 hrs
Kosirev ³⁹ 1927—M , 25	Stab w'd l a		O F 4-5-6-7	no	Stitch inf bilat pneumothorax	Rec

RIGHT AURICLE

Puccinelli ⁴⁰ 1925—M	Stab w'd r a		Exp lap Resect 3-4-5-6	yes	Pneumothorax, hemathorax	Rec
Bagroff ⁴¹ 1929—M , 20	Stab w'd r and l a	3 hrs	Resect 4-5	no	Wound of septum	Died on table

STAB WOUNDS OF THE HEART

MISCELLANEOUS CASES

Surgeon Date Age and Sex	Etiology Location	Time before Op	Type of Operation	Dram	Complications	Result
O'Day ¹² 1927—M	Punct w'd	sev hrs	O F			Rec
1927—M	Stab w'd	6 hrs	P F			Rec
Luthr ¹³ 1926—M, 13	Gunshot w'd			no	Hydropicard	Rec
1926—M	Gunshot w'd			no		Rec
Simcom ¹⁷ 1925—M, 16	Stab w'd		Resect 4-5	yes		Rec
Farina ⁴¹ 1930—F, 30	Stab w'd		Resect 6	yes	Hemathorax, malaria	Rec
1930—	Lac peri- cardium			yes		Rec
Guisevas ⁴¹ 1929	Stab w'd					Rec
1929	Stab w'd					Died 10th day
Sudhoff ²² 1928—M, 48	Stab w'd epicar- dium pericar- dium					Rec
Wagner ⁴⁶ 1926—M, 28	Stab w'd r v and l v and coronary art	1 ½ hrs	Midsternal			Died 1 hr
Kingma-Boltjes ⁴⁷ 1928—M, 21	Stab w'd	1 ½ hrs	Extended laparotomy			Rec
Co ³¹ 1928—M, 26	Stab w'd 5 mm from cor- onary artery	2 ½ hrs			Cardiac decompen- sation, pneumonia, staph pericarditis	Rec

MISCELLANEOUS CASES (*continued*)

Surgeon Date Age and Sex	Etiology Location	Time before Op	Type of Operation	Drain	Complications	Result
Moritsch ²⁷ 1930—M, 30	Stab w'd pericar- dium Stab w'd rt auri- cle—not sutured		O F 4-5-6	yes	Hemopericardium, pericarditis, portal thrombosis, infarct liver	Died 72 hrs

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THE OPERATION OF CARDIOLYSIS IN ADHESIVE PERICARDITIS WITH PICK'S SYNDROME^{*}

BY MORRIS H. PIERSOL, M.D., GEORGE C. GRIFFITH, M.D.,
FLOYD J. O'HARA, M.D.

AND

WALTER ESTELL LEE, M.D.

OF PHILADELPHIA, PA.

SURGERY of the heart and pericardium has become a reality only in recent years. The belief of Aristotle,¹ who said, "The heart alone, of all viscera, cannot withstand serious injury," was still present in the minds of many as late as the end of the nineteenth century. Billroth,³ in 1883 stated, "Let no man, who hopes to retain the respect of his medical brethren, dare to operate on the human heart." In 1896, Stephen Paget¹⁰ concluded "Surgery of the heart has probably reached the limits set by nature to all surgery. No new method or new discovery can overcome the natural difficulties that attend a wound of the heart." During this time, however, the progress of cardiac surgery was not at an absolute standstill. As early as 1648 Riolanus¹⁴ advised trephining of the sternum for drainage of the pericardium, but it was not until 1819 that Romero¹² of Barcelona performed the first successful pericardiectomy.

Surgical intervention, as a possibility for adhesive pericarditis, was suggested by Weil⁶ in 1895. He recognized the fact that, after the adhesions have reached the fibrous stage, medical therapy is illusory, and said, "It will one day come within the province of surgery to deliver the heart from the shell which strangles it." Pick¹¹ gave an impetus to a better understanding of cardiac pathology when in 1896 he explained a type of cirrhosis of the liver, due to a primary adhesive mediastino-pericarditis. Pick drew a rather fine distinction between polyserositis, and mediastino-pericarditic pseudo-cirrhosis of the liver. The latter entity has been called Pick's disease.

Delorme⁷ went a step farther than Weil. He made detailed observations on cadavers and found that it was possible to free the adhesions between the heart and pericardium, and in 1898, in numerous addresses at clinical societies of Paris, he proposed this type of operation. He was not successful in having his work received with favor. Even as late as 1929, Lockwood⁸ advised against this serious procedure. Reim⁹ in 1920 is commonly accredited as being the first to carry out the suggestions of Delorme, although Sauerbruch¹⁷ as early as 1913, operated upon a case in which a portion of the pericardium was resected, with resulting freedom from symptoms.

One reason that the suggestions of Delorme were not carried out was the proposal of a simpler procedure by Brauer⁵ in 1902. Brauer's operation consists of the removal of several ribs and costal cartilages on the left side of the precordium. This relieves the heart of pulling against a hard non-elastic bony framework and allows it to contract and pull against the soft parts of the chest wall. This type of operation was successfully performed by Professor Petersen, April 1, 1902.

Before deciding between a Brauer type of cardiolysis, and a decortication of the heart as suggested by Delorme, it is necessary to recognize two distinct groups of

^{*} Read before the Philadelphia Academy of Surgery, May 1, 1933.

cases. The commonly recognized type is that in which the pericardium is held firmly adherent to the chest wall by adhesions. This fixation throws an added strain on the heart, and is apt to cause cardiac decompensation. It is in this type of case that a cardiolysis, as suggested by Brauer, was supposed to be of benefit. However in reality, there is no clear-cut distinction between these two groups of cases. Volhard¹⁵ expresses the feeling that the difference lies more in the degree of contraction than in the type of adhesions. Very seldom will a simple rib resection give relief from the symptoms. In view of the present advances in cardiac surgery we feel a Delorme decortication is as a rule indicated.

One great danger in operative work on the pericardium is the possibility of injuring the pleura, which occurred in our first case. In approaching the pericardium through the anterior chest wall, the attempt is made to reach the heart through the "triangle of safety." This is a small triangular area, first described by Voennitch¹⁷ in 1897, uncovered by pleura and situated in front of the pericardium and beneath the sternum (Fig. 4). It is described as extending from the level of the sternal end of the fourth rib, down to the junction of the gladiolus with the ensiform. The size of this area is extremely variable, depending upon the size of the patient and the type of the thoracic cage. Our post-mortem studies have shown that frequently the pleura of the right lung extends across the pericardium to the left border of the sternum. Instances were found in which the pleura of the right and left lungs overlapped in the mid-line, as low as the level of the sixth costal cartilage, thereby greatly complicating the operative approach to the heart.

Bouine⁷ mentions two other dangers that may be encountered in operating on the heart. The first is that which may occur as a result of firm adhesions to the chest wall and neighboring tissues. The second is the danger of rekindling local inflammatory conditions by mechanical interference. This was a complication in the first case we operated upon.

The trans-sternal approach is a comparatively easy way to reach the heart, but does not give sufficient exposure. Splitting of the sternum has been suggested, but the shock accompanying such a procedure does not warrant its use. A chondroxiphoid approach was described by Laithey⁸ in 1829 for the drainage of purulent pericarditis. Beck² suggests the use of an H-shaped incision. Shipley¹⁶ has devised a combined trans-sternal and chondroxiphoid approach, and considers this to be the method of choice. In this, the sternum is trephined just above the junction of the gladiolus and sternum, and a little to the left of the centre. This opening is then enlarged to the left and upward with rongeur forceps until the left lateral segment of the sternum and the ends of the third, fourth, fifth and sixth cartilages are cut away. This exposes the uncovered portion of the pericardium and the left margin of the pleura. The left pleura can then be reflected laterally and the pericardium opened.

CASE I—An adult male, J. Mc., age twenty-five, entered the Graduate Hospital of the University of Pennsylvania November 15, 1932, complaining of swelling of his legs and face. He was in good health until 1925, at which time he had bilateral pneumonia and was in bed two weeks. There was no resulting incapacity, and he remained well

for approximately one year. Since 1926, he has had intermittent œdema of the legs which disappeared upon exercise. In 1929 this œdema had increased and in addition, he had noticed a swelling of the face, present only in the morning upon arising. About 1929, the patient began drinking heavily, becoming intoxicated three to four times a week. At one time the œdema was so severe that he was admitted to another hospital, when the œdema subsided after one week in bed and he gained fifteen pounds in the next six months. At no time did he have any symptoms other than œdema and when admitted to the Graduate Hospital œdema of the face was present in the mornings and a pitting œdema of the lower extremities. There was engorgement of the neck veins when recumbent, which remained full, with definite pulsations, when he was erect. The lungs were essentially clear. The heart was slightly enlarged to the left but otherwise normal, with a rate of 72, and blood-pressure 115/80. The liver and spleen were enlarged. The liver was firm, not tender, and a sharp edge was easily palpable. There was no evidence of ascites.

Shortly after admission, he was seen by Dr. H. L. Bockus, who made the following note: "The problem here is to explain the combination of dependent edema and edema of face which has been intermittently present for a number of years, which he states has been improved by exercise. Studies at another hospital suggest the presence of myocardial changes, which if present might account for the enlarged liver and spleen. Cardiac symptoms have never been marked. The history of alcoholism in association with a large, firm liver necessitates eliminating primary diffuse liver disease, but I can hardly account for the edema in the absence of ascites. A true nutritional edema seems unlikely in view of the serum proteins and absence of history. My impression is that the etiological factor here may be simultaneously affecting the heart, liver, spleen and kidneys."

Because of a suggestive hypopituitary makeup, scarcity of hair, soft velvety skin, and abnormal distribution of fat, an X-ray examination of the sella turcica was made and it was found to be normal.

The venous pressure in both upper and lower extremities was 250 millimetres of salt solution. Other laboratory reports were essentially normal. The electrocardiographic examination showed a suggestion of coronary artery disease or pericardial adhesions. Fluoroscopic examination showed fixation of the heart, with very little, if any, excursion during contraction. Films revealed the heart increased in size, with pleural pericardial adhesions chiefly on the right, and involving the right auricle to the greatest extent.

The case was studied by Doctor Griffith who, in a summation of the findings, noted: "(1) Venous engorgement and dependent edema, with liver and spleen enlarged. (2) Very little cardiac enlargement with negative physical findings. (3) A lowered arterial tension. (4) History of bilateral pneumonia. (5) Increased venous pressure (normal 110 millimetres salt solution). With the above five facts, a diagnosis of constrictive mediastino pericarditis (Pick's Disease) is warranted."

The patient was operated on February 6, 1933, by Doctor Lee. Avertin anæsthesia, 90 milligrams per kilo body weight was used, supplemented by gas-oxygen under positive pressure given by Doctor Beach.

A curvilinear incision was made which started at the anterior axillary line over the second rib, curved forward until it reached the middle of the sternum opposite the fourth rib, then curved backward to the left until it reached the left costal arch at the seventh rib which was then followed down to the anterior axillary line.

The skin and muscles were dissected and reflected as a flap as far as the left anterior axillary line. The sternum and the second to seventh costal cartilages were thus exposed. With a Hudson drill a trephine opening was made in the midline of the sternum opposite the sixth costal cartilage. This opening was enlarged until the periosteum on the under surface of the sternum was visible. With this as a guide to protect the pleura, a channel was made in the sternum extending from the xiphoid to the level of the second costal cartilage. The perichondrium was separated from the sixth costal cartilage

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which was then excised as far as its junction with the rib. In like manner, the fifth, fourth, third and seventh costal cartilages were removed.

The pulsation of the heart was then visible and an incision was made through the substernal periosteum opposite the sixth costal cartilage. Fortunately, this incision entered the triangle of safety. This opening was enlarged until the edge of the left pleura was exposed. The pericardium was identified, grasped with two hemostats and incised. The pericardial incision was then carried upward, making it possible to develop a line of cleavage between the pericardium and the left pleura. The left pleura was gradually pushed away from the pericardium until the mid-clavicular line was reached. In the same way, the right pleura was reflected and by pulling the pericardium to the left it was exposed for nearly one and one-half inches. The pericardium was found to be quite adherent to the epicardium over most of the right and left ventricles, but at the apex a line of cleavage was developed, though the separation required considerable force. At the apex and on the posterior surface of the heart there were ten to twelve fibrous bands about the size of the corda tendinae, measuring 2 by $3\frac{1}{2}$ centimetres in length. They were easily divided, after which the inferior vena cava was exposed. A piece about 6 centimetres in length and 3.5 centimetres in width was removed from the left half of the anterior portion of the pericardium, and during this excision a hole was accidentally made in the left pleura. Doctor Beach increased the positive pressure of the gas oxygen anaesthesia, which inflated the lung, visualizing the opening in the pleura and preventing collapse of the lung. A mattress suture of linen successfully closed the pleural opening. The right pleura was then dissected further away from the surface of the anterior pericardium and a strip 3.5 centimetres wide by 5.5 centimetres long was removed. The boy's pulse rate rose at this time and his blood pressure fell, and Doctor Beach advised against any further surgery. In removing a flap of soft tissues consisting of the perichondrium and interosseous muscles, the left pleural was again entered, but was immediately closed by mattress sutures of linen. The skin and subcutaneous tissues were closed without drainage by mattress sutures of dermol.

Anæsthetic Notes by Doctor Beach—"Avertin anaesthesia 6.8 cc in distilled water, 272 cc (90 mgm) for 165 pounds, was injected and the patient was asleep in five minutes. When the incision was made, nitrous oxide and oxygen was started and continued for the balance of the operation. During the operation for four-fifths of the time the mixture was below 75 per cent nitrous oxide and 25 per cent oxygen, the greater part of the time the mixture was 50 per cent of each. The pressure was never above 7 millimetres. The blood pressure rose in the early part of the operation and remained fairly consistent. The pulse was never fast, but became intermittent during the manipulation of the heart. The lung pressure was easily maintained when the pleura was opened twice. The patient reacted before leaving the table."

The post-operative course was quite stormy. His progress was satisfactory until about the sixth post-operative day, when there was a serous discharge from the lower angle of the wound. The venous pressure at this time had fallen to 120 millimetres of salt solution. A smear made of this discharge revealed Gram-positive diplococci in cocci in short chains. Later, culture showed streptococcus hemolyticus and staphylococcus albus. We feel that a latent pneumococci and streptococci infection of the pericardium was stirred up by the surgical procedure. The streptococcus and staphylococcus outgrew the pneumococcus in the culture media.

He developed an irritative cough the tenth post-operative day, when physical and X-ray findings demonstrated a hydro-pneumothorax. Thoracentesis of the left chest was performed, removing 800 cubic centimetres of purulent fluid. A catheter was introduced into the pleural space, and the continuous type of closed drainage was instituted.

Closed drainage with hourly irrigation with salt solution was continued for two weeks, at which time the X-ray examination showed complete drainage of the left pleural cavity. About this time the lower angle of the wound separated and a purulent discharge started.

There was a gradual improvement for about one month but he then began to fail. During this time a portion of the wound edges separated, and the heart could be seen in the depth of the wound. Pus was aspirated daily from the cavity of the wound and the empyema. In spite of blood transfusions and other symptomatic treatment, the patient died April 22, 1933, ten weeks after operation. The venous pressure never rose above 120 millimetres of salt solution after operation.

At autopsy, it was found that there had been no regeneration of the ribs or costal cartilages. The gaping wound opened into the open pericardial cavity. The edges of the wound in the anterior chest wall were smooth and granulations were present. The cut ends of several ribs were exposed and necrotic. The pericardium on the left side was adherent to the chest wall, below, to the diaphragm and part of the chest wall, and on the right side to the under surface of the sternum. There were no communications found between the sac and the peritoneal cavity or the sac with the left pleural cavity. There was also present a chronic plastic pleurisy, right chest, hæmorrhagic infarcts, right lung, multiple miliary abscesses, right lung, abscesses, right chest wall, empyema left chest, atelectasis, left lung, chronic adhesive pericarditis with myocardial degeneration, multiple miliary abscesses of the kidneys, and chronic passive congestion of viscera.

In addition to the important surgical problems presented by Case 1 we feel that it was of exceptional medical interest, especially from the diagnostic standpoint. It was necessary to explain the peculiar type of œdema and at the same time to account for the enlarged liver and spleen.

It will be recalled that the man's œdema was marked in the face every morning after being recumbent and by night the œdema had largely disappeared from the face only to become worse in the lower extremities. In short the degree of œdema and its location was modified by gravity. The engorgement of the veins, especially of the neck and face, accompanied by marked increase in venous pressure made it evident that this œdema was due to some form of venous obstruction and that this obstruction had to be situated so as to obstruct the blood flow from both the superior and inferior vena cava. The logical place to look for such an obstruction was the mediastinum.

The earlier thought that the œdema was of nephritic origin had to be abandoned when it was found that the urine contained only small and variable amounts of albumin from time to time that the kidneys were still able to concentrate well, that there was no elevation of arterial pressure and that there was no increase in the total non-protein nitrogen of the blood and the urea clearance was normal. The diagnosis of lipid nephrosis was untenable when the serum proteins were not reduced and the serum albumin-globulin ratio was normal even though there was a slight increase in the blood cholesterol.

The examination of the heart was essentially negative, the heart was not enlarged, no murmurs were heard, and there was no arrhythmia, there was no evidence to justify a diagnosis of myocardial failure. Therefore, it was unreasonable to explain the œdema on purely cardiac grounds.

The enlarged liver might have been responsible for œdema of the lower half of the body, but it could not account for the œdema of the face.

Furthermore, in the absence of ascites it seemed most improbable that the liver could be a causative factor of the œdema.

It seemed much more plausible that the œdema, large liver and spleen were all the result of a common cause. The diagnosis of constrictive mediastino-pericarditis arrived at by the clear and careful reasoning of Doctor Stroud and Doctor Griffith was amply confirmed by the roentgenological findings which showed marked diminution in the intensity of the cardiac impulse because it was so bound down by pleuro-pericardial adhesions the result of an old plastic pleuro-pericarditis or mediastinitis. There was considerable distortion of the right auricle suggesting adhesions about the right auricle which could readily account for the stasis in the greater venous circulation. On the basis of this conception, the enlarged hard liver and spleen could easily be explained as due to chronic passive congestion. On the other hand, the history of alcoholism could not be put aside and the possibility of the enlarged liver being the seat of a chronic hepatitis of toxic origin had to be considered. Such an opinion was strengthened by finding evidence of liver dysfunction, namely an increase in urobilinogen (1-50) and impaired galactose tolerance, indicating parenchymal liver damage.

The etiology of the chronic adhesive mediastino-pericarditis was undoubtedly the severe pneumococcic pneumonia which this patient suffered seven years before. The frequency with which pericarditis complicates pneumococcic infections should be remembered and this case furnishes a good example of the serious sequelæ that may occur.

CASE II—White male, R. K., age thirteen, admitted to the Graduate Hospital of the University of Pennsylvania January 10, 1933, with complaint of swelling in face and abdomen. He was entirely well until 1929. About that time his parents first noticed that when the patient was cold, his lips became cyanotic. Shortly afterwards, swelling of the abdomen was observed, then swelling around the eyes and face, while later pulsation and engorgement of the veins of the neck, and œdema of the ankles. All of these symptoms had been intermittent in character until two months previous to admission, since which time they had been constant. His right chest was tapped twice during the month of November and sterile fluid was obtained, but paracentesis of the abdomen was unsuccessful. During the past three years, the patient had never been bedfast. He was rather poorly developed. His skin had an ashy appearance, with visible smaller superficial veins. The lips were quite cyanotic. His eyes showed a venous engorgement of the retinal veins. An examination of the chest revealed a dullness to percussion at the basis of both lungs, with a suppression of breath and voice sounds. Examination of the heart was essentially negative, with the blood-pressure 90/65. The abdomen was large and protuberant. Dullness to percussion in the flanks, and a distinct fluid wave regarded as positive evidence of ascites. The liver was palpated and found to be smooth and firm. There was a moderate amount of cyanosis of the feet and hands.

X-ray report of January 10, 1933. "There is a marked change in the cardiac silhouette which is now more or less tent-shaped, with considerable calcification present in the anterior inferior left lateral surfaces (Fig 1). The pleural pericardium is thickened and adhesive on the right, having completely obliterated the right cardio-phrenic angle and the right costo-phrenic sulcus, with marked thickening of the pleura over the right lower lobe, and to a less extent over the entire right lung. There is

also evidence of slight thickening of the pleura of the left lower lung, partially obliterating the left costo-phrenic sulcus (Fig 1A)

"The definite findings therefore are an old, fairly well-organized and calcified, pleural pericarditis with the involvement chiefly in the areas above noted, and with an old pneumopleuritis in both bases, with much more thickening at the right base than at the left. This is the kind of case in which surgical intervention is to be considered. Because of involvement of the pleura and the history of ascites this case might be one which falls in that group of polyserositis and even after surgical removal of a portion of the pericardium, may go on to rapid formation vitiating whatever surgical procedures are attempted." Dr J G Cohen

The electrocardiographic examination showed myocardial degeneration, but no marked inversion of T^1 , T^2 and T^3 waves as one would suspect in this degree of pericardial damage. This study showed absolute fixation of the heart. The cardiac output was estimated as 11 cubic centimetres per stroke volume. His venous pressure was 240 millimetres of salt solution. Other laboratory studies were essentially normal.



FIG 1—(Case II R K) The ventricles surrounded and strangled by a calcified shell of pericardium



FIG 1A—Case II showing effusion in right pleural cavity

Doctor Griffith saw the patient January 26 and stated "Because of apparent pleural thickening and ascites, and the very marked calcification of the pericardium, I suggest postponement of any surgical procedure." On a later date, January 28, he made a further note "After careful discussion of the entire problem with the patient and his parents they have asked that the pericardium be explored to determine whether something could not be done to release the heart from its sac of calcified pericardium."

First operation—The patient was operated on February 22, 1933, at the Graduate Hospital by Doctor Lee. Under avertin anaesthesia, using 90 milligrams per kilo of body weight supplemented by gas-oxygen anaesthesia given by Doctor Beach, a curvilinear incision was made which started at the anterior axillary line over the second rib, curved forward until it reached the middle of the sternum opposite the fourth rib, then curved backward to the left until it reached the left costal arch which was followed down to the anterior axillary line (Fig 2). This incision was carried through the skin and subcutaneous tissues and the sternum when the dissection was carried outward, detaching the insertions of the pectoralis major and minor muscles until the anterior axillary line

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was reached. The periosteum of the anterior surface of the sternum was then dissected away and the sternum was drilled with a Hudson burr in the mid-line and at the level of the sixth costal cartilage, to the depth of the posterior layer of the periosteum. Three openings of this type were made in the sternum, the upper one being at the level of the third costal cartilage. These openings were connected by removing the intervening bone with rongeur forceps. After completing this channel in the centre of the sternum the left half of the sternum was removed until the costal cartilages were reached. At this point the perichondrium and the periosteum of the fourth costal cartilage and rib were separated, both anteriorly and posteriorly, and all of the fourth costal cartilage and about 1 centimetre of the fourth rib were removed. Following this the third costal cartilage was removed. Then the fifth, sixth, and seventh costal cartilages were removed, all subperichondrially. Although the lungs could be seen through the transparent parietal pleura in the intercostal spaces, the pleura was not opened. Incision was then made through the remaining posterior layer of the periosteum of the sternum at the level of the sixth costal cartilage, and this incision was separated with the blunt points of the hemostat when the right pleura immediately bulged through this opening. The patient was receiving positive pressure by the McKesson gas-oxygen apparatus and this made possible a demonstration of the position of the right pleura.

The boy's condition at this time was critical and Doctor Beach felt that we could not complete the operation and that we had better stop and do it in two stages. This was in agreement with Doctor Lee's judgment and that of Doctor Flick, who was watching the procedure. The edges of the wound were approximated with interrupted dermal sutures and no drainage was employed.

Doctor Beach, who gave the anaesthesia, noted a sudden reaction to avertin before operation commenced. This cyanosis cleared upon the administration of oxygen and nitrous oxide. During the remainder of the operation, the patient was maintained without cyanosis. The percentage of gas was nitrous oxide 50 to 75 per cent and oxygen 50 to 25 per cent. The pulse was intermittent, especially as the ribs were being stripped and pressure was made upon the heart. The positive pressure used was not over 5 millimetres at any one time. The patient reacted immediately upon withdrawal of the anaesthetic.

The second operation was performed on March 22, 1933. Our judgment in stopping the first operation when we did seemed to have been justified by the stormy recovery which followed. During the first two or three days post-operatively he complained bitterly of the atmospheric pressure on his chest. There was respiratory embarrassment, the respirations becoming rapid, the cyanosis increased and he had a definite cough which, of course, was very painful because of the wound in his chest wall. At the end of a week he seemed to have recovered from the acute symptoms and then he developed a fever which was unexplainable. There was no infection in his wound and apparently no accumulation of fluid. His fever gradually subsided after three or four days and



FIG 2—Photograph of the scar of the first operation taken just before second operation

during the next ten days he rapidly improved, regaining his normal morale, but the fluid in his right chest increased, the ascites also increased and a definite œdema of the scrotum, which was much more marked than at any previous time. Immediately following the operation and for possibly two weeks there was very definite pulsation of his precordium, but this gradually decreased and when examined on March 21 there was no visible pulsation of his precordium. There was no fall in the venous pressure following this Brauer type of operation, remaining at 240 millimetres of salt solution.

Second operation, March 22, 1933—Under avertin anæsthesia, using 90 milligrams per kilo of body weight, supplemented by gas-oxygen anæsthesia given by Doctor Beach. Doctor Lee reopened the incision of the wound made at the first operation, and developed a line of cleavage and a flap of skin, subcutaneous tissue and muscle was separated by blunt dissection from the underlying tissues of the chest wall. To our surprise and misfortune it was found that cartilage had been reformed by the perichondrium which we had allowed to remain, but not the bone. Thus instead of exposing the pericardium as we had hoped, it was necessary to practically do the operation over again under more difficult conditions than had existed at the primary operation. An incision was then made in the posterior layer of the periosteum of the sternum and again the right pleura bulged through this incision. However, by using a blunt periosteal elevator, we were able to develop a line of cleavage between the periosteum and the pleura, when the periosteum was incised from the level of the seventh costal cartilage to the third, and the parietal pleura, first of the right lung and then of the left lung, was dissected away from this periosteum. The pleural surfaces were nowhere adherent, and the positive pressure of anæsthesia given by Doctor Beach beautifully demonstrated the position of these pleural membranes and made it possible for us to avoid injuring them. A great deal of time was spent in dissecting the pleura away from the periosteum and intercostal tissues, but this was accomplished for a distance of about 5 centimetres to the right and the left of the incision in the pericardium. It was found that the right pleura came over to the left edge of the sternum, where it met the left pleura as far down as the level of the fifth costal cartilage. At this point they separated, making a circular area of about 2 centimetres (Fig 3) in diameter which was free of pleura, but below this they met again, so that instead of having a triangular area of safety from which to approach the pericardium, we had a circular area of about 2 centimetres in diameter. The pericardium was then incised and it was found to be about 3 millimetres in thickness and to contain so much calcium that it was impossible to cut it with the scalpel, and scissors had to be used. The longitudinal incision which was made in the calcified pericardium allowed for the herniation of a very thin membrane which resembled the endothelial tissue of the pleura. This membrane seemed to have fluid beneath it. It was possible to separate this membrane from the under surface of what was taken to be the calcified pericardium, so that the true epicardium was at no time exposed. This longitudinal incision was continued upward until the level of the third costal cartilage was reached, beyond which level there was no calcification, and it was continued downward as far as the diaphragm. Grasping this calcified pericardium with forceps, it was possible to dissect, by means of a blunt periosteal elevator, the firmly attached pleura of the right lung. This dissection was carried to the right for a distance which permitted the removal of a section of 4 centimetres in width. This removal started at the upper angle of the longitudinal wound and was carried to the right beyond the area of calcification, but when the diaphragm was reached the calcification appeared and felt very much like the surface of a tiled pavement. The left pleura was then dissected away from the pericardium in the same manner as the right, but a wider section, 5 centimetres in breadth, was removed from the left side (Fig 4). The pleura was not injured in the removal of either of these sections of tissue. Before the removal of this calcified tissue, one could not see the pulsation of the heart although it could be felt. The pulse rate was 124 and Doctor Beach said that the patient was beginning to show the effects of the surgical trauma. The systolic pressure was 70 and the diastolic was 50. With the release of the strangling pressure of this calcified shell the systolic

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Fig. 3—(Case II) R K, showing the contact of the right and left pleural site except for the small area of the

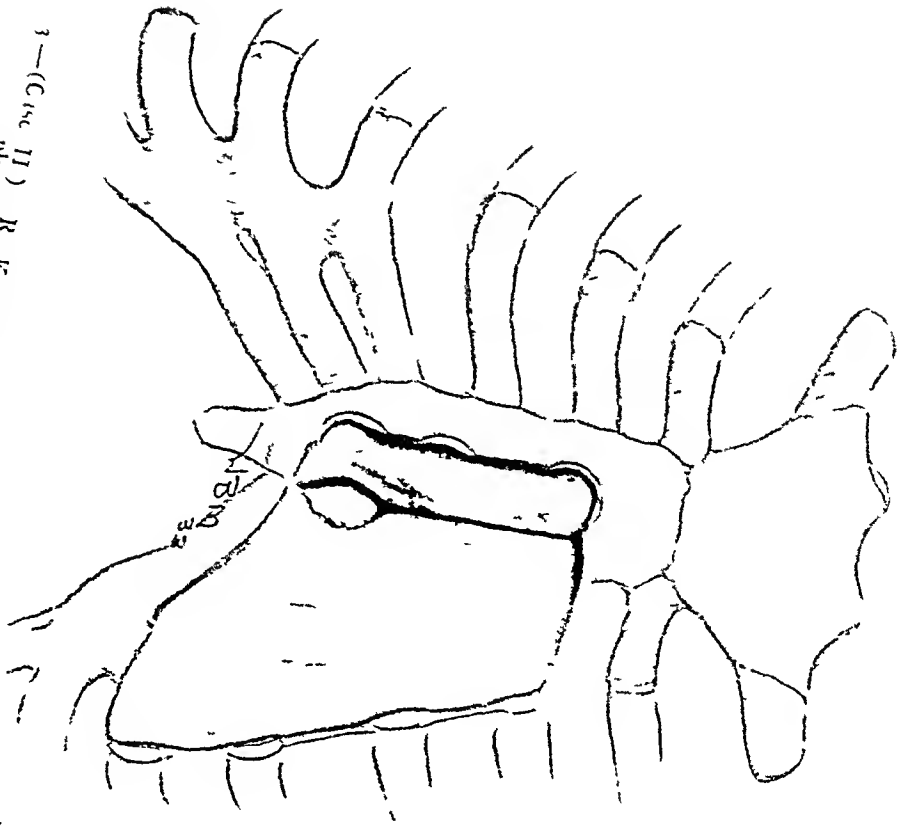
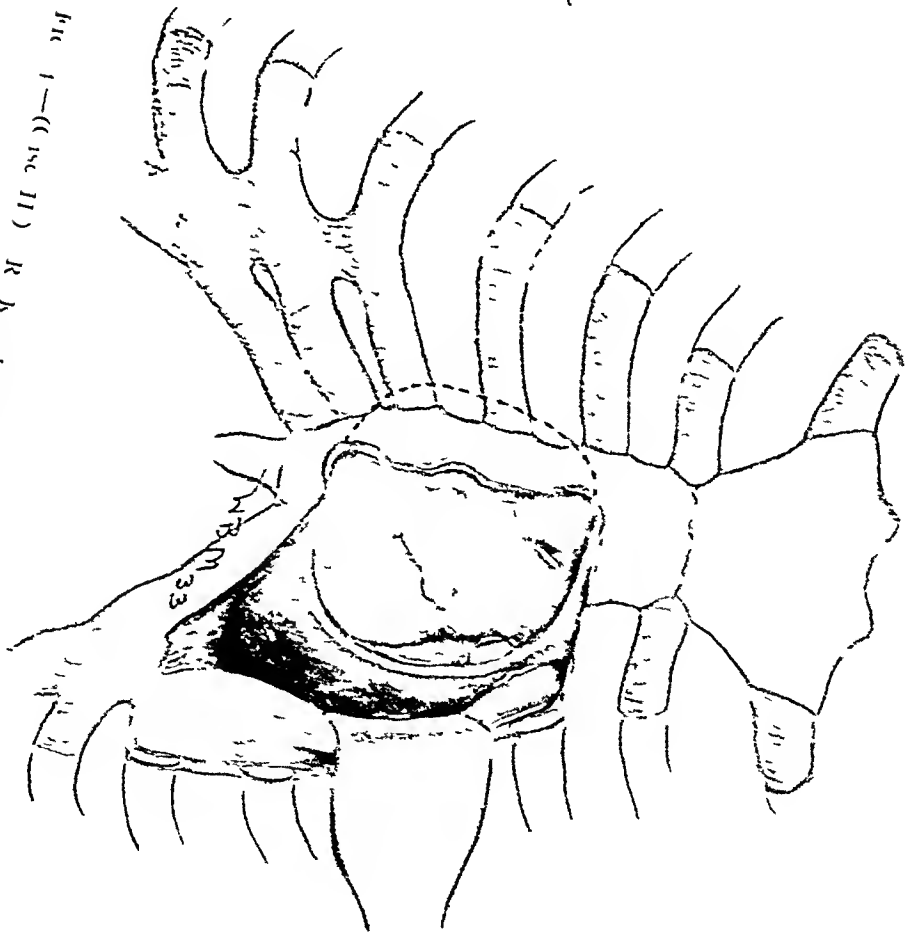


Fig. 1—(Case II) R N, showing the extent of the removal of the adhered pericardium



pressure rose to 110 and the pulse rate fell to 90 and the general conditions dramatically improved. Of course with the removal of the calcified membrane the heart expanded and bulged through the opening made in the pericardium. The heart was not embarrassed at all, except at one time when we were removing the calcified tissue from the left ventricle in the only area in which it seemed to be intimately adherent to the thin endothelial membrane which has been previously described. Every time we made an attempt to remove this calcified tissue the heart would stop and it required a number of attempts before the line of cleavage was found, but it was finally accomplished without tearing this endothelial membrane. Our explanation of this endothelial membrane was that the calcification had taken place in the fibrous layers of pericardium and that the endothelial layer, or inner surface of the pericardium, was separate from it (Fig 4). The patient's condition was really very much better after the removal of this calcified membrane than at any time during the operation, so that it was possible to deliberately and carefully close the wound (Fig 5). In addition to the figure of eight dermal



FIG 5—Calcified pericardium removed at operation

sutures and vertical mattress sutures, four tension sutures with rubber buttons to protect the tension points were used to close the wound. No drainage was employed.

Anæsthetic Notes by Doctor Beach—"The patient was cyanotic before the avertin was injected but this cyanosis did not increase. He reacted when ether was applied to the chest (ether used in cleansing skin). Nitrous oxide averaged around 75 to 25 per cent, and at times reached 50 per cent oxygen. The pulse was weak and irregular with not much variation in pulse pressure. The heart action was embarrassed when pressed upon. The whole cardiac picture improved after the pressure of pericardium was released. He reacted well before leaving the operating room."

Post-operative recovery was very satisfactory. Patient was slightly nauseated the first day. He complained of some pressure on chest, but in no wise as severe as after the first operation. On the fourth post-operative day, a bulging was noted over the upper part of incision in which there was considerable fluctuation. A needle was inserted and 15 cubic centimetres of clear fluid were removed. This, most likely, was pericardial fluid. Examination chemically was essentially negative, upon culture it was found to contain staphylococcus albus which was most probably a skin contamination. On April 8, he developed an upper respiratory infection which soon cleared up.

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April 23, 1933 At this present time, oedema of legs is absent Scrotal oedema has disappeared There is still some ascitic fluid present His venous pressure is 170 millimetres of salt solution and blood-pressure is 110/75
"X-ray examination shows the process in the left lower lobe has abated consider-



FIG 6—(Case III) R K Photographs taken four weeks after operation

ably, and there is nothing visible at this time except a moderate thickening of the pleura over the left base, partially obliterating the left costo-phrenic sulcus There is still a localized pleural effusion undergoing regression, and probably organization over the right lower lobe The window from the anterior calcified pericardium that was re-

moved is distinctly shown by the defect now present in an area about 6 centimetres in length, by about 4 centimetres in width" (Fig 7)

Dr Griffith reports October 5, 1933, "very great improvement The blood-pressure has climbed to normal His heart rate is 80, and there is no evidence of increased venous pressure The liver is barely palpable, and the spleen cannot be palpated There is no œdema of the extremities His mother states there is the greatest difficulty in keeping him from playing actively with the other boys"

The second case presents many features of importance to the internist, although the diagnostic and therapeutic problems involved differ from those met with in the first case



FIG 7—(Case II) R K X ray taken four weeks after operation, showing the defect of the window removed from the calcified pericardium

For some time before this patient came under observation in the hospital it was recognized that he was suffering with ascites, a large liver, and bilateral pleural involvement At that time from physical signs alone it was impossible to demonstrate with certainty the existence of a chronic mediastino-pericarditis This is not infrequently the case and the recognition of chronic pericarditis often depends upon keeping in mind the possibility of its presence In this instance the existence of a chronic mediastino-pericardial lesion was strongly suspected because of the early occurrence of persistent ascites

with an enlarged smooth liver before any marked œdema of the ankles was observed and the development of pulsating engorged cervical veins with swelling and cyanosis of the face, the symptoms indicative of superior as well as of inferior caval obstruction

It remained for later X-ray and electrocardiographic studies to confirm this suspicion The former clearly showed the presence of a thickened calcified pericardium binding down the heart and causing distortion of the normal cardiac silhouette as well as pleuro-pericardial adhesions and bilateral pleurisy with a right-sided effusion Although the electrocardiogram failed to show

the inversion of the T wave in all leads that would be expected in such an extensive chronic pericarditis, it did demonstrate fixation of the heart. Added evidences of pericardial constriction were the diminished cardiac output and the marked increase in venous pressure. It was, therefore, possible to demonstrate in this patient the two distinctive signs of a chronic constrictive pericarditis, namely, fixation of the heart and an enlarged liver with ascites out of proportion to the œdema of the legs.

After it was determined that chronic constrictive pericardial changes were present in this patient, the diagnostic problem then to be settled was whether the fundamental difficulty was pericardial, with the pleural exudate, hepatic enlargement and ascites all secondary to the circulatory obstruction brought about by the pericarditis, or whether the pericardial and other changes were but part of a polyserositis.

In constrictive pericarditis the hepatic veins may easily be obstructed so that hepatic enlargement, congestion, and finally some degree of chronic hepatitis with ascites results. This condition described first by Pick in 1896 is often referred to as Pick's disease or mediastino-pericarditic pseudo-cirrhosis of the liver. Polyserositis, on the other hand, is a different condition although the two diseases have frequently been confused in the past and may coexist. Polyserositis is associated with a chronic perihepatitis in which the capsule of the liver becomes tremendously thickened, giving rise to the so-called sugar-icing appearance. The condition involves little, if at all, the liver parenchyma. The process apparently starts as a low-grade chronic inflammatory reaction of the peritoneum about the diaphragm and upper abdomen and gradually involves the pericardium and one or both pleural cavities. The similarity of the two conditions and the fact the mediastino-pericarditis may result from polyserositis makes it obvious that they are not easily to differentiate. Perhaps the two conditions are not essentially different.

On the other hand, from the standpoint of surgical treatment it would seem worth while to try to draw a distinction between the two conditions. In Pick's disease, if the symptoms are primarily the result of pericardial constriction, cardiolysis would seem to offer more hope of relief than in polyserositis in which the chronic inflammatory process continues even if compression of the heart is temporarily relieved.

It was for this reason that operative procedures in the case under discussion were undertaken only after careful study and deliberation. The successful result reported and the marked improvement in the boy's symptoms would seem to justify amply the operation and indicate that in this case we were concerned more with Pick's syndrome than with a true polyserositis.

What the etiology of the constrictive pericarditis was in this case is not clear. The commonest cause of a chronic adhesive pericarditis is a preceding acute rheumatic infection. In this instance there was no history of rheumatic fever and no evidence of endocardial involvement. On the other hand, in earlier childhood a mild or atypical rheumatic infection may have occurred,

as is so often the case, and a slight acute pericarditis may easily have gone unrecognized. There was no evidence in this patient of tuberculosis, another common cause of chronic pericarditis. He had never had pneumonia which was responsible for the pericarditis in the first case. It is undeniably true that a number of cases of chronic pericarditis develop from no discoverable cause. In this group probably a low-grade streptococcal infection of unknown origin is at the root of the trouble. Such may have been the case in this patient. On the whole, however, in view of the early age of onset, the widespread occurrence of the rheumatic state, and the absence of any demonstrable focus of infection, it seems more than likely that in this patient, the constrictive pericarditis and its train of dire symptoms was the result of a rheumatic infection.

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SURGERY OF THE INFERIOR VENA CAVA¹

CLINICAL AND EXPERIMENTAL STUDIES

BY WALTMAN WALTERS, M D , AND JAMES T PRIESTLEY, M D

OF ROCHESTER, MINN

FROM THE DIVISION OF SURGERY OF THE MAYO CLINIC

ALTHOUGH the inferior vena cava is not often disturbed surgically, occasionally it may be opened, and in such event satisfactory hemostasis must be secured. The vena cava is most often entered, either intentionally or otherwise, during the course of operation on the right kidney. In theory more than in practice, numerous operative procedures on this vessel have been suggested for the cure or alleviation of various diseases. Most of these proposed operations appear theoretically sound, although in reality they remain largely conjectural and are of doubtful clinical value. It is of interest, however, to consider such procedures in the light of the present-day status of vascular surgery, as undoubtedly they constitute a field for investigation. For example, anastomosis between the inferior vena cava and portal vein, preferably without ligation of the portal vein, if performed in the early stages of portal cirrhosis, might conceivably eliminate injury to the liver and simultaneously prevent hæmorrhage from an engorged varix developing secondary to the intrahepatic obstruction of the portal vein. This operation was performed successfully in man by Rosenstein¹⁰ in 1912, and has been undertaken occasionally since that time, however, it still remains of undetermined clinical value.

Literature—Lafont, Houel and Ferrari¹¹ reported nine cases in which the inferior vena cava was ligated near the source of its origin, either with or without operation on the pelvis, for the treatment of severe puerperal utero-pelvic phlebitis. Five of the nine patients survived the operation and recovered from the puerperal infection. Complete ligation of the inferior vena cava has been reported by many observers,^{2, 16} usually as a procedure of necessity in removing malignant tumors of renal or other origin. Pfaff¹⁸ reviewed nineteen such cases from the literature in which the mortality was 32 per cent, and Makaschew¹² reported eighteen cases, with an unfavorable outcome in 33 per cent. Wakefield and C. W. Mayo,²¹ in a careful clinical and pathological study of obstruction of the inferior vena cava distal to the renal veins, concluded that the deep collateral circulation is usually adequate to compensate for occlusion of the vena cava at this level. General experience tends to indicate that ligation of the vena cava below the level of the left renal vein (provided the right kidney has been removed) if the patient is in fair general condition, usually will be followed by the development of adequate collateral

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circulation. If, however, the vena cava is ligated above the site of entrance of the left renal vein at the time the right kidney is removed, death will occur in almost every instance. Following complete ligation of the inferior vena cava there is usually temporary œdema of the lower extremities, and if the patient is a woman there may be an increase in the menstrual flow for a few months.²⁰⁻²² Patel and Peycelon,¹⁷ in France, and Dannheisser,⁶ in Germany, who have had both clinical and experimental experience in this field, regard ligation of the vena cava as the procedure of choice in many cases in dealing with injury to this vessel below the left renal vein. Other observers consider that, in most injuries of the vena cava, complete ligation of the vessel is unnecessary and usually not desirable. Although Horsley¹⁰ has shown that a single catgut ligature placed around one of the larger arteries may only temporarily occlude the flow of blood in this vessel, the lumen of the vena cava will not be reestablished in sufficient time to prevent a fatal outcome owing to congestion of the kidneys and resultant renal insufficiency.

Excellent results have been reported by suturing the vessel, or by the application of large smooth forceps which are left in place.^{1, 3, 4, 5, 15, 16} Most surgeons are of the opinion that suture is probably the ideal procedure, but they regard the use of clamps as a good substitute when circumstances do not permit accurate suturing. Partial or lateral ligation and packing with gauze have been tried in some cases with unsatisfactory results.

Although clinical experience in surgery of the inferior vena cava has been somewhat limited, experimental investigation with operative procedures has been more extensive. Approximately fifty-five years ago, Eck⁷ first described the technic of anastomosing the portal vein and inferior vena cava, in the performance of what is now called Eck fistula. In the original operation described by Eck, two rows of sutures were used and the stoma was established with the use of scissors. There have been many modifications of this method. Mann, in working out the first satisfactory method for removal of the mammalian liver, has developed a simplified technic based on the use of the cutting suture described by Fischler and Schroder.⁸ He uses only one row of sutures, performs the operation without clamps, reduces the length of time necessary to establish the anastomosis, and obtains highly satisfactory results with a low mortality rate.⁹ By ligating the vena cava on the cephalic side of the stoma, and subsequently ligating the portal vein at its site of entrance into the liver, complete hepatectomy may be performed after a period of a few weeks, with no appreciable disturbance in the venous return from the abdomen and lower extremities. In endeavoring to evolve a simplified preliminary technic for hepatectomy, Markowitz demonstrated that two-thirds of the vena cava of the dog could be ligated at the original operation, usually without any demonstrable ill effects. As anomalies in small venous tributaries are common, considerable individual variation among the animals was encountered.

Experimental Work—In an effort to evaluate clinical suturing of the vena cava, as occasionally performed in conjunction with right nephrectomy, experiments were conducted

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on dogs. In one series of animals a longitudinal cut was made in the vena cava and hæmorrhage was promptly arrested by the application of smooth-jawed curved forceps. A mattress type of suture was then applied directly underneath the clamps, which were then removed. In the second series of animals, the flow of blood in the vena cava was first occluded by placing serrefine clamps on the vessel above and below the exposed area. A segment of the vein was then excised and the defect repaired by a single row of No. 0 oiled silk sutures. The vessel was reduced to approximately half of its former size by this procedure. The serrefine clamps were then removed, and before the wound was closed the suture line was inspected to determine whether bleeding was completely controlled. From forty-eight hours to four weeks after operation, the animals were killed and a careful examination made. The segment of the vena cava at the site of the former operation was removed for gross and microscopical inspection. Both series of animals were operated on without mortality.

In each animal a satisfactory lumen was present in the vena cava, and in none was



FIG. 1



FIG. 2

FIG. 1—Section through the wall of the vena cava forty-eight hours following suture of the vessel. Cellular activity is most apparent in the adventitia, surrounding the suture material.

FIG. 2—Marked fibroblastic proliferation in the adventitia of the vena cava forty-eight hours following operation.

there extensive thrombosis. In the animals killed early following operation there was a small thrombus, densely adherent on the intimal side of the suture line. This was never sufficiently large, however, to reduce materially the lumen of the vein. It subsequently underwent organization and cicatrization, as evidenced by the specimens examined later. The lungs were examined carefully but pulmonary infarcts or emboli were not discovered.

Although we did not attempt to make an exhaustive study of the healing processes in the vena cava, serial sections through the site of operation were made in each case for microscopical study. Besides the usual hematoxylin and eosin stain, van Gieson's and Mallory-Heidenham's stains were used for more careful observation of the connective tissue. In the sections removed forty-eight hours after operation, the cytological reactions directed toward healing were apparent in the adventitia by centres of fibroblastic proliferation (Figs. 1 and 2), which apparently arise around the smaller blood-vessels in this outer coat. These cells subsequently migrated toward the suture line. At that time there was

no sign of healing in either the intima or the media. Four or five days later an aggressive cytological response was present. A wedge-shaped formation of fibroblasts and polymorphonuclear leucocytes was found growing into the gap between the cut surfaces of the intima and media (Fig 3). These cells apparently arise largely from the proliferative collection seen originally in the adventitial layer. It is likely, however, that the media and perhaps the intima may contribute in part to this cone of tissue as both of these layers were thicker and more cellular than normal. There was evidence of cellular activity in the intima which suggested that proliferating cells from this layer grow out over this wedge or plug to form the new intimal layer. Likewise the media showed aggressive reaction by the presence of polymorphonuclear leucocytes which were engulfing remnants of necrotic tissue. At this time recovery was well advanced, muscle bundles were forming in the media and new fibrous tissue was found in the adventitia. Two weeks after operation the



FIG 3



FIG 4

FIG 3—Connective tissue cone protruding as a bud shaped projection within the lumen of the vena cava, seven days following incision and suture of this vessel.

FIG 4—Reestablishment of smooth intimal surface and cellular reaction surrounding sutures fourteen days following operation on the vena cava.

surface of the intima was smooth, but not completely covered with endothelial cells. There was a firm fibrous foundation for further healing in the media (Fig 4).

Four weeks following operation, recovery was complete in that the cut surfaces were firmly united (Fig 5). Although large numbers of migratory cells were still present, the opposing surfaces of the media were securely united with muscle and fibres of connective tissue. Cicatrization appeared practically complete in the adventitia and repair of the intima was almost concluded (Fig 6). The silk suture had not absorbed, and there was some evidence of a low-grade reaction surrounding it.

Clinical Considerations—Intentional Opening of the Vena Cava—Deliberate incision of the vena cava may be indicated in the removal of a neoplasm which has invaded the renal vein and extended into the vena cava. Obviously if this portion of the growth is not removed, it is merely a question of time until a portion of it will become dislodged and be carried into the pulmonary

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circulation, giving rise to widespread metastasis. Evidence of metastasis may occur soon after the removal of a hypernephroma in cases in which the pre-operative roentgenogram of the thorax had been negative.

Technically, deliberate opening of the vena cava for the purpose of removing malignant tissue is not unusually difficult, provided the proper equipment for vascular surgery is available. The presence and extent of the growth within the vessel must first be determined. The flow of blood in the vena cava is then stopped by placing serrefine clamps or small rubber-covered clamps, similar to Doyen forceps used on the stomach, above and below the malignant extension in the vessel. After removal of the kidney the renal

artery is securely ligated and the renal vein is explored. Any remnants of tumor tissue are then gently removed. If, during the process, a portion of the wall of the vena cava is removed, this may



FIG 5

FIG 5—Complete formation of endothelial lining on the intimal surface of the vena cava twenty eight days following operation.



FIG 6

FIG 6—Interior of the vena cava, revealing the smooth intimal surface twenty eight days following suture.

be repaired with a specially prepared silk suture. The rubber-covered clamps previously placed on the vena cava are removed and the operation is concluded as in performing any nephrectomy. Deliberately opening the vena cava in this manner does not usually offer the difficulties often encountered when the opening is accidental. Occasionally it is not necessary to open the vena cava for the purpose of removing a papillary neoplastic extension as the growth may be pushed back with the fingers into the renal vein and removed with the kidney. Two illustrative cases follow.

CASE I—Projection of hypernephroma removed from vena cava. Bleeding controlled with suture. A woman, aged fifty-three years, who registered at the clinic May 2, 1932, gave a long history suggestive of duodenal ulcer. In the course of physical examination a large, movable mass was discovered in the region of the right kidney. Roentgenograms of the stomach revealed an obstructing duodenal ulcer. Urological examination revealed

that renal function on the left side was normal but was markedly reduced on the right side. From the pyelographical evidence of deformity, the diagnosis of tumor of the lower pole of the right kidney was made.

Because of the obstructing duodenal ulcer, posterior gastroenterostomy was performed May 7, 1932. Two weeks later, following an uneventful convalescence from the gastric operation, right nephrectomy was done for what proved to be a hypernephroma with extension into the renal vein and vena cava (Fig 7). The renal capsule was extremely vascular, containing many veins one centimetre in diameter. The kidney was greatly enlarged and a portion of the tumor could be felt extending through the renal vein into the vena cava. After the kidney was removed, a soft rubber-covered Doyen clamp was placed across the lower portion of the vena cava, an opening made in the latter and the tumor tissue extracted. The opening in the vena cava was temporarily closed with curved clamps and then sutured with an oiled silk suture. The operation was concluded in the usual



FIG 7—Hypernephroma of right kidney with extension into vena cava, removed from Case I

manner. A transfusion of 500 cubic centimetres of blood and 450 cubic centimetres of acacia was given.

Convalescence was without event and the patient left the hospital on the eighteenth day. Six weeks later the patient returned for a course of deep Rontgen-ray therapy, she was in excellent general condition at that time.

CASE II—Papillary projection of right hypernephroma removed from vena cava
A woman, aged seventy-two years, registered at the clinic December 7, 1932. She stated that her general health had always been good until one year previously. In the last year she had lost weight and strength. Recently she had noted occasional attacks of urinary frequency, but no other localizing symptoms. Her weight was 197 pounds.

Physical examination revealed a large, firm, rounded mass in the right renal area suggestive of an enlarged right kidney. The urine was normal except for an occasional erythrocyte. Urological investigation demonstrated that the left kidney was essentially normal, and that there was a deformity visualized pyelographically in the right kidney, suggestive of polycystic disease or neoplasm. A diagnosis of right renal tumor was made.

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December 14, 1932, right transperitoneal nephrectomy was performed for hypernephroma. On mobilization of the kidney, which was approximately three times normal size, it was found that the tumor involved primarily the lower pole and had extended into the vena cava. By squeezing the inferior vena cava at its juncture with the renal vein, the projecting part of the tumor was pushed into the renal vein and entirely removed with the kidney. It was not necessary to incise the vena cava. Three ligatures were placed on the renal pedicle and the operation was concluded in the usual manner. Exploration of the left kidney did not reveal abnormality.

Post-operative convalescence was without event and the patient left the hospital on the thirteenth day after operation. Apparently she has been in good health since then.

Unintentional Opening of the Vena Cava—With few exceptions, the vena cava is opened unintentionally only when the right kidney is being removed, the greater length of the left renal vein helps to obviate this occurrence during left nephrectomy. This accident happens most often in two types of cases: (1) those in which a badly inflamed, atrophied, pyonephrotic kidney which may have been subjected to previous nephrostomy is being removed, and (2) those in which a renal neoplasm is being removed. In these cases the renal pedicle is shortened, infiltrated and difficult to isolate. The kidney, secondary either to inflammatory or malignant changes, lies close to the vena cava and may be adherent to it at one or more points. Unless extreme care is exercised when such a kidney is mobilized the vena cava may easily be torn. Certain procedures aid in avoiding this undesirable occurrence.

A subcapsular type of nephrectomy is particularly helpful in dealing with a pyonephrotic kidney. Mobilization of the kidney is greatly facilitated by first stripping the capsule, thus minimizing the danger of injuring adjacent structures. The capsule is pushed back to the renal hilus, where it is incised to aid isolation and clamping of the pedicle. Unfortunately, in certain cases, particularly in tuberculous or malignant disease of the kidney, subcapsular nephrectomy is not feasible as it is important to remove the capsule and as much surrounding fatty tissue as possible in order to avoid leaving infected or involved tissue behind. In dealing with a malignant renal tumor, on the other hand, approach through a transverse or right rectus incision materially increases exposure and thereby reduces the hazard of injury to the vena cava. Cabot,¹ who generally employs this type of incision in operating on renal neoplasms of any magnitude, considers it far superior to the usual postero-lumbar route. He feels also that the chance of peritoneal contamination is minimal. To avoid unintentional opening of the vena cava it is helpful to use only the gentlest manipulation in mobilization of the kidney. Excessive trauma in the dissection or undue traction on the renal vessels may readily cause a rent in the vena cava. Performance of the maximal amount of dissection possible under direct vision will also obviate many undesirable accidents. It is far more desirable to consume a little extra time by a slow, careful and gentle dissection than by haste to make an accidental rent in the vena cava.

Accidentally injuring the vena cava, in performing nephrectomy, usually occurs in one of three ways: (1) inclusion of a portion of the vessel in the

lower clamp on the renal vessels, (2) tearing a portion of the vena cava which is adherent to the kidney, as the latter is mobilized, in which event the openings may be multiple, and (3) avulsion of the renal vein at its site of entrance into the vena cava by undue traction on the renal pedicle. Careful and gentle manipulation with adequate exposure usually will prevent this accident, however, because of the numerous operative difficulties which sometimes arise it is really surprising that it does not occur more frequently.

The position of the opening in the vena cava will vary according to the factors responsible for the opening, which may be either above the entrance of the renal vein, at the point of its entrance, or below this level. Occasionally it may occur at all three levels, which is the most undesirable accident possible. Openings high in the vena cava, just below the liver, are the most difficult to repair because of their inaccessibility.

Caring for Opening in the Vena Cava Made Unintentionally—Two methods of treatment may be mentioned: immediate control and permanent control of bleeding. The first intimation of the accident is the gushing of dark venous blood from somewhere in the depths of the wound which rapidly obscures vision. As W. J. Mayo¹⁴ pointed out in 1914, when considering accidental injuries to the descending portion of the duodenum during removal of the right kidney, one should restrain any immediate impulse to apply clamps blindly to structures submerged in blood. The vena cava will not be accurately caught at the site of the tear, and the duodenum, which is nearby and in this region relatively fixed, may be clamped and later give rise to a duodenal fistula. The pressure in the vena cava is low, and the bleeding may be readily controlled by digital pressure or compression between the fingers. After the bleeding is stopped and the field is cleared by sponging, efforts must be made to arrest the hæmorrhage permanently. If the kidney has not yet been removed, this should be accomplished with dispatch while bleeding from the vessel is controlled temporarily with the fingers.

Five different methods have been advocated for the permanent control of bleeding from the vena cava: (1) packing, (2) partial or lateral ligation, (3) complete ligation at one or more levels, (4) application of clamps which are left in place, and (5) suture of the tear. Attempted hemostasis by packing the wound with gauze is one of the least desirable procedures. In most cases reported in the literature in which this treatment was used, the termination was fatal. Partial or lateral ligation of the vena cava is likewise not very satisfactory. The opening in the vessel must first be clamped with forceps and then ligated. As can readily be seen, the torn edges of the vena cava tend to retract and may easily slip out of the ligature. Nineteen cases of complete ligation of the vena cava with six deaths were reviewed by Pfaff,¹⁸ who maintained, contrary to most opinion, that this procedure is usually the one of choice. The ligatures must be applied below the entrance of the left renal vein or death by uræmia is almost inevitable. If the patient is in fair general condition and the ligature is placed properly, complete oc-

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clusion of the vena cava frequently may not cause undesirable effects other than temporary œdema of the lower extremities. It is at best a drastic and usually an unnecessary procedure. Under conditions existing at the time of operation it may be difficult to determine the exact level of entrance of the left renal vein into the vena cava.

Accurate application of large, smooth-jawed, curved clamps to the defect in the vena cava is one of the most common procedures and also one of the most satisfactory. After the operative field has been cleared one or more clamps may be applied securely. The clamps are surrounded with iodoform gauze and left in place. The handles of the clamps are tied securely with fishline and then protected externally with a box placed over the wound. They are undisturbed for one week, at the end of which time they are gently unclamped with a minimal amount of motion. Twelve to thirty-six hours later the exudation of serum around the vena cava will have loosened the clamps somewhat from the walls of the vessel and they may then be removed without resultant bleeding.

Suture of a tear in the vena cava is probably the ideal means of controlling hæmorrhage from this vessel. While bleeding is still controlled with digital pressure, two serrefine clamps or small thin-bladed rubber-covered clamps are placed on the vessel, one above and one below the opening. These clamps effectually control bleeding and the finger may then be removed. Under clear vision, the defect in the wall can be carefully sutured, using a specially prepared, oiled, silk suture embedded in the end of a small flexible straight needle. A long, light-weight needle holder facilitates suturing. Covering the suture line with a pad of fat, as advocated by W. J. Mayo, adds to the security of the closure. When this type of closure can be accomplished, it affords, we believe, the safest and most conservative procedure, and for these reasons is the method we prefer whenever it is applicable.

CASE III—Unintentional opening of the vena cava during right nephrectomy for pyonephrosis. Bleeding controlled with clamps. A man, aged fifty-five years, registered at the clinic September 28, 1927, stating that right-sided abdominal pain had developed four weeks previously for which an emergency appendectomy had been performed elsewhere. Five days later he began to have chills, fever and frequency of urination. These symptoms had persisted to the time of admission.

On admission, the patient was acutely ill and immediately hospitalized. He had a septic type of fever, ranging as high as 104.5° F., during the ensuing few days. Cultures of the blood showed the presence of Gram-positive cocci. There was an indefinite, tender mass in the right flank. Urological investigation revealed obstruction to the right ureter five centimetres above the bladder. The diagnosis of acute right pyonephrosis was made. The value for urea in the blood and the function of the left kidney were normal.

October 6, 1927, right nephrectomy was performed. Acute purulent pyelonephritis was present, and the kidney was surrounded by considerable perinephritis, as evidenced by the friable, œdematous, perirenal tissues. The kidney was half again normal size and the ureter twice normal size. The renal pedicle was unusually short and in elevating the kidney the vessels of the pedicle and apparently a portion of the vena cava were torn. In order to obtain better exposure, subperiosteal resection of the twelfth rib was per-

formed. The bleeding vessels were secured with six large curved clamps which were left in place. The clamps were surrounded with iodoform gauze and the wound was left open. A transfusion of 500 cubic centimetres of blood was given while the operation was being concluded.

Post-operative convalescence was somewhat prolonged but uneventful. Four days after operation the forceps were loosened and twelve hours later they were removed. Eight days after operation the gauze pack was removed. The wound was closed several weeks later.

The patient was seen again in June, 1928, at which time his general health was excellent, and the left kidney functioned normally. Slight residual cystitis remained. He returned in September, 1932, complaining of slight pain in the left renal area. Obstruction low in the left ureter, found at this time, yielded readily to manipulative dilatation. The patient's health has since been excellent.

CASE IV—Unintentional opening made in the vena cava during removal of a neoplasm from right kidney. Bleeding controlled with suture and clamps. A man, aged thirty-three years, registered at the clinic March 10, 1933, with the complaint of repeated attacks of pain in the right flank during the last seven years. Gross hæmaturia had occurred four or five times during this interval. Recently the hæmaturia recurred and was more persistent.

The right kidney was enlarged and palpable. Rontgenogram of the kidneys, ureters and bladder disclosed multiple scattered areas of calcification in the right renal area. Considerable distortion was noted on retrograde and intravenous urography in the lower calices of the right kidney. The left kidney functioned normally. The diagnosis was made of neoplasm of the right kidney with calcification.

Right nephrectomy was performed March 15, 1933, for a large (fourteen by twelve by seven centimetres) papillary, calcareous, degenerating adeno-carcinoma, graded I. Exploration through a posterolumbar incision disclosed a large kidney containing numerous cortical abscesses. The kidney was densely adherent to surrounding structures and there were numerous engorged veins in the perirenal tissues. The kidney was gradually mobilized and separated from the retroperitoneal duodenum without injury to the latter, however, several openings were made in the vena cava when the adhesions between this vessel and the kidney were separated. Bleeding was controlled by digital pressure and then large, curved clamps were applied. The lower opening in the vessel was carefully repaired with an oiled, silk suture and the clamps were removed from this region. A higher tear in the vena cava, however, was too inaccessible for satisfactory suture. Five curved clamps were left in place on this portion of the vessel. A transfusion of 500 cubic centimetres of blood and 400 cubic centimetres of acacia was given at the conclusion of the operation.

Convalescence was without event. The clamps were loosened one week later and in twelve hours they were removed without resultant bleeding. The patient left the hospital on the sixteenth day after operation in good general condition.

SUMMARY—There are few definite indications for operation on the inferior vena cava. During the course of right nephrectomy this vessel may be opened either intentionally for the purpose of removing a papillary projection of a renal neoplasm, or unintentionally, during mobilization of a densely adherent kidney. The methods of dealing with tears or incisions in the vena cava are considered. Experimental observations on healing in the wall of the vena cava, following suture, are reported. The possibilities for future investigation in operating on the vena cava are mentioned. Four illustrative clinical cases in which the vena cava was opened are presented in abstract.

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THE CAUSATION AND TREATMENT OF MULTIPLE ADENOMATOSIS OF THE COLON

By J P LOCKHART-MUMMERY, F R C S ENG

OF LONDON, ENGLAND

SENIOR SURGEON TO ST MARK'S HOSPITAL FOR DISEASES OF THE BOWEL

THIS curious and rare disease has received considerable attention in recent years, partly because of the difficulty experienced in finding any satisfactory method of treating it, and partly because of the very marked tendency there is for the unfortunate victims to die of cancer. It was first described by Virchow¹ in 1863, and Harrison Cripps² described a case in 1882. Although the disease has accumulated a very considerable literature, most of the authors³⁻⁶ have merely given details of individual or collected cases and described the symptomatology and results. The majority have failed to draw any distinction between cases of polypi in the colon resulting from irritative or infective causes, and the cases here considered, of multiple adenomatosis of the colon occurring as an hereditary disease complex, which form a distinct disease entity, quite separate in origin from the cases due to an infective cause.

In 1927 an excellent paper appeared in the *British Journal of Surgery* by J H Saint⁵ in which he reviewed all the literature on the subject of polypi of the intestine. He attempted to divide the cases of multiple polypi of the colon into two classes, those due to ulceration and those which are not. He rightly pointed out that the cases associated with ulceration, which were described as colitis polyposa by Virchow, Struthers, and others, are not true adenomata, but glandular hyperplasia. Many authors have described these cases and attempted to prove that the adenomata resulted from inflammation or some form of local irritation, such as the presence of parasites. A good deal of confusion has arisen from the failure of many authors to distinguish between those cases of apparent multiple tumours resulting from severe ulcerative colitis, and the true cases of multiple adenomata where no ulceration or inflammation is present, and this confusion even exists in most pathological museums. The appearance of tumours in old cases of ulcerative colitis is due to islands of inflamed mucous membrane left behind by the ulceration. It is very evident, if specimens are carefully examined, that these apparent tumours are not true adenomata. A very excellent review of the whole literature of these curious cases was made by Dr Cuthbert Dukes⁴ in the *Cancer Review* for April, 1930. In it he reviewed all the literature since the publication of Harrison Cripps' cases in 1882.

One of my chief objects in writing this paper is to point out that there is a definite disease entity, called "Multiple Adenomata of the Colon" which occurs as a familial disease, and is quite independent of any similar conditions produced by infection or ulceration. This disease is in a similar category to hæmophilia, albinism, brachydactyli, deaf-mutism and other similar hereditary

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conditions, which are handed down from one generation to another either as Mendelian dominants or recessives. Since 1925 a great deal more care has been taken to trace the family histories of these cases and it is now thoroughly established that multiple adenomatosis or polyposis is an inheritable disease, which is transmitted by both sexes, and attacks both sexes. It appears to be a Mendelian dominant. An interesting point in connection with it is that the children are not born with it, but tend to develop the condition about the time of puberty. This is particularly interesting from a genetic point of view, and in this respect it differs from most of the well-known hereditary diseases. While in most cases the disease first develops at puberty, or in early adult life, in a few cases it does not develop till considerably later. One of my cases,³ a man of thirty-nine, was very carefully examined by me with the sigmoidoscope because I knew he came from a family with the disease, and I found his colon quite normal. Yet four years later this patient, when again examined, was found to exhibit the disease in a well-marked form, and a sister of his has recently developed the disease at the age of thirty-seven. I have never seen a case in an infant, nor is there, I believe, any authentic case on record. The adenomata do not appear as a rule to form before puberty, and in this respect it differs from many other hereditary diseases although there are other abnormal conditions showing the same peculiarity. Thus hereditary optic atrophy comes on about puberty and hereditary amaurotic family idiocy first shows its appearance at from five to seven years of age.

It is only comparatively recently that our knowledge of biology had given us the clue to the origin of such conditions, but there can be no doubt that in the near future this type of disease, or abnormality, will receive a great deal more attention, both from medical men and from research workers than has hitherto been the case, since such conditions fall into a class of their own, and so to speak belong to an entirely new chapter in the book of medical knowledge, a chapter which we have only just begun to read. In the light of modern biology we are now able to explain such conditions as this, and although to some people the explanation may appear fantastic, it will soon be a well recognized factor in medicine.

A change, or mutation, has taken place in the genes of some individual who has not personally exhibited the diseased condition, but who has passed the mutated genes on to his descendants. We cannot trace the origin of this disease, but in the case of hæmophilia we can with fair certainty say that the mutation occurred in some ancestor of the Coburg Royal family some two or three hundred years ago. Friedreich's ataxia appears to have arisen in one of the Swiss valleys several generations ago, but we are only just beginning to study these hereditary diseases from the genetic standpoint, and the time at which they started cannot be fixed with any accuracy from the available data.

It can be definitely asserted that adenomatosis is an example of gene mutation. There are numerous other examples of diseased conditions, which

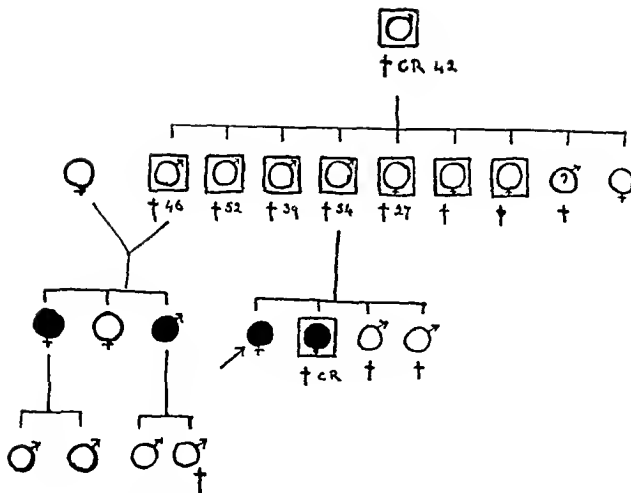


FIG 1—Author's case The woman to whom the arrow points has had colectomy performed

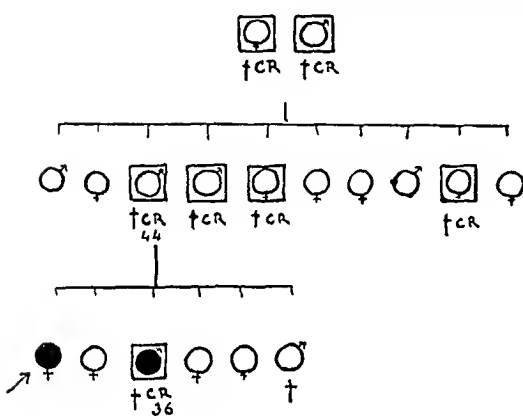


FIG 2

FIG 2—Author's case The individual to which the arrow points has had colectomy performed and is the only surviving member of the family that can be traced

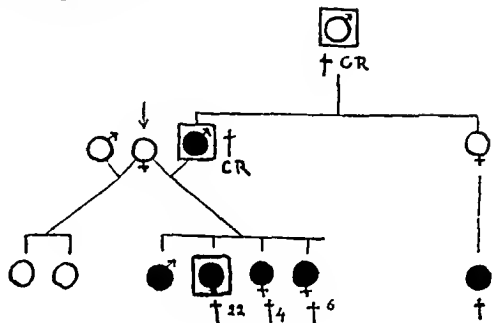


FIG 3

FIG 3—Zahlmann's case Note that the woman to whom the arrow points had been married before to a man free from the disease and she herself was presumably free and had two healthy children by him Her four children by her second husband (who suffered from adenomatosis and died from cancer) all developed the disease

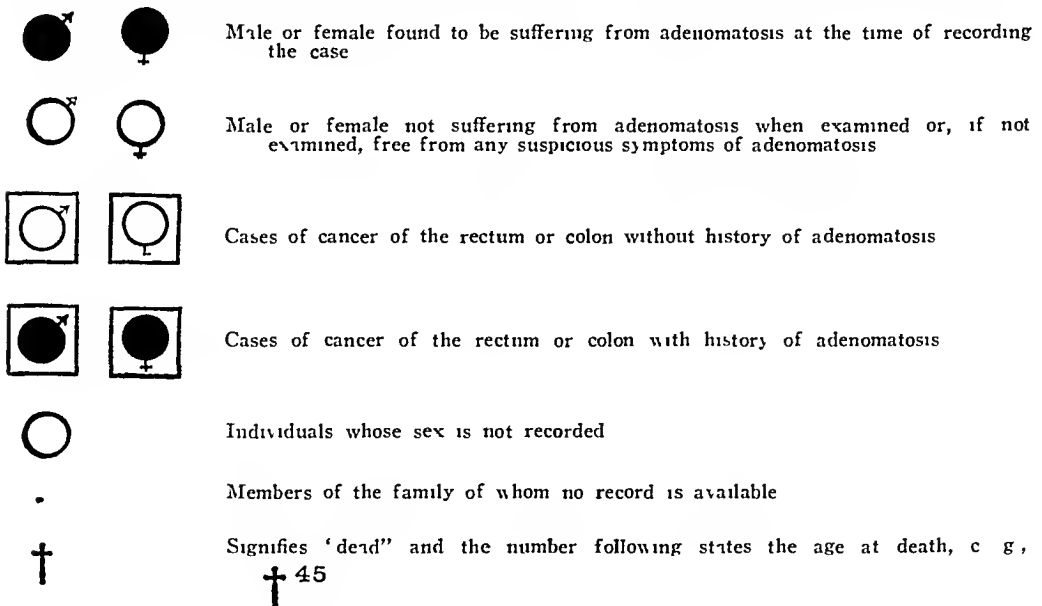


FIG 4—Key to Conventions used in Pedigree Charts

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must also be considered as the result of mutations, and so far very few have been carefully studied from this point of view. When a mutation of the genes has taken place, the results may appear in succeeding generations either as dominants or recessives. If as a dominant the condition will tend to occur in every generation, but if the disease is a recessive it will only be seen when both parents carry the mutated genes, which may not occur for very many generations, and then the hereditary factor is very likely to be missed.

The genetic origin of several of these cases of adenomatosis has now been carefully traced, and no one who studies these family histories can doubt that the condition is definitely hereditary.

As already stated the condition is not found in infancy. We must, therefore, conclude that the hereditary factor is the susceptibility of the epithelial cells of the large intestines to proliferate at a certain age. In most cases this age appears to be about the age of puberty, most of the patients first exhibiting symptoms at ages from about twelve to twenty. The result is the formation of numerous simple adenomata throughout the large intestine. The actual number of adenomata in any individual case is often quite uncountable. The other feature of the disease which is of particular interest is that after a certain time there is a very marked tendency for one or more of the adenomata to form the starting point of a malignant adeno-carcinoma. A careful microscopic study of some of these cases shows that the tumors do not suddenly become malignant, but that one small portion only of the tumor changes its character and becomes a cancer and that this gradually spreads until it has destroyed the remainder of the simple tumor. This tendency for the simple tumors to become malignant is very marked in this disease, so much so, that practically all the patients develop carcinoma sooner or later, and mostly at quite an early age. In a few cases several of the adenomata become malignant simultaneously. The probable explanation of this secondary malignant change is that the rapidly proliferating tissue, of which there is an enormous quantity in the numerous adenomata, affords a great opportunity for another mutation for malignancy to occur in the rapidly reproducing cells of the adenomata. We know that all adenomata are liable to undergo malignant change and it follows that if there are a very large number of adenomata the chances of a mutation for malignancy of the somatic cells will be very much greater. The particular interest of these cases lies in the fact that neither the adenomata nor the cancer which is superimposed at a later time are hereditary in any strict sense. The hereditary factor which is passed on from one generation to another as a Mendelian dominant is the susceptibility to excessive proliferation of the epithelial cells of the colon.

I do not propose to discuss at length the symptoms of the condition, nor the diagnosis. The symptoms are those of ulcerative colitis, with mucus, diarrhoea and blood, and the diagnosis is easily established by an examination with the sigmoidoscope. Quite recently we have been trying at St Mark's Hospital, and they have also been trying at the Mayo Clinic, to find a technic

which will make it possible to demonstrate the condition by means of X-ray enemata, so that the actual extent of the disease in the colon can be discovered, as the sigmoidoscope only makes it possible to see the condition as far as the lower end of the colon. That it has been found possible to demonstrate the condition with X-rays will be seen by this photograph (Fig 5) which is reproduced from a photograph made by Doctor Henderson the radiologist at St Mark's Hospital. So that it should be possible now not only to make a diagnosis of the condition, but to tell with fair certainty the extent of the lesion in the colon.

Treatment—To turn to the question of treatment. This is an extremely difficult matter. The importance of being able to do something is obvious since the vast majority of these patients with multiple adenomatosis die from



FIG 5—Adenomatosis of the colon

cancer at a very early age, and the tendency to secondary development of cancer is so great that anything that will tend to prevent it would seem to be justifiable. It is, I think, obvious to anyone looking at the specimens that no treatment short of complete colectomy can be of any avail, and even that cannot completely eradicate the disease, as several of the adenomata will still remain in the rectum. The latter can, however, be removed locally, as they occur, by keeping a careful watch upon the patient. Complete colectomy, which will have as a rule to be carried out in a young person between the ages of eighteen to twenty-five is a very serious and mutilating procedure, and may not

seem justifiable. On the other hand if these cases are left untreated they will almost certainly die of cancer at an early age, so that drastic measure would seem justifiable. The following case well illustrates this.

The patient was a servant girl, aged eighteen, who was sent to me by a doctor in the Midlands. She had typical adenomatosis involving the rectum and the whole of the colon up to the cæcum. She was so young that I hesitated to do a complete colectomy and I, therefore, sent her home and wrote to her doctor asking him to keep a watch on her. He sent her back to me four months later, as he considered she was so much worse that a colectomy was justifiable. On examining her again on her return I found a large carcinoma had developed in the rectum since she had been seen four months previously. The tumor was nearly three inches across and had already perforated the bowel wall and invaded the deep lymphatics, although four months previously there had been no sign of it when she was examined. In order to try and save her life I had to do a colectomy of the greater part of the colon and the whole of the rectum. She re-

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covered from the operation and is well one and one-half years later, but the prognosis is not good

The first case of colectomy for adenomatosis was, I believe, performed by Doctor Lilienthal in America. The operation was done in three stages. I performed my first colectomy for this condition in 1918, and I have in all done four complete colectomies for this disease. All the patients were young women under twenty-four years of age at the time of operation, and at the present time they are all alive and well, but they have to be examined every six months, as there is a tendency to recurrence of the adenomata in the rectum. When these tumors are discovered they are removed locally either by diathermy or by the application of nitric acid. The first patient operated upon fifteen years ago is still in good health, although all her brothers and sisters, aunts and uncles, have died, those who did not die in infancy having died of carcinoma. Her sister, two years younger than herself, died of carcinoma six years ago. The operation, therefore, would seem to have been more than justified in her case.

In one case an attempt was made to deal with the condition by means of X-rays. The patient was given deep X-ray therapy to the whole of the colon. The result was to make him very unwell for a time and he was some six months recovering. The effect of the X-rays upon the tumors was that they appeared to stop growing, or at any rate they grew much more slowly for a time, and some appeared to be turned into fibrous tumors, although three years later he still had extensive adenomatosis and the tumors appeared to be again growing. Further treatment with X-rays was not considered justifiable in view of its comparative failure on the first occasion.

Unsatisfactory as it may seem, complete removal of the colon would appear at present to be the only method of treatment for these cases that is worth considering.

These cases have all now been watched for a considerable time, and it is evident that the absence of a colon does not prevent satisfactory nutrition, as none of them have exhibited any permanent loss of weight, and two at least have put on weight. Slight looseness of the bowels is present in all of them, but in none is it sufficient to cause any serious inconvenience.

SUMMARY

(1) Multiple adenomatosis of the colon is due to a gene mutation inherited as a Mendelian dominant, for excessive proliferation of the epithelium of the colon at about the age of puberty.

(2) The chief danger of the condition is that secondary carcinomatous change takes place in the adenomata which results in death from cancer at an early age.

(3) The only treatment that seems to have any chance of success is early complete colectomy, followed by local removal of the tumors in the rectum at six monthly intervals.

(4) With this treatment patients can live for long periods free from symptoms and are protected from developing cancer

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SURGICAL TREATMENT OF VARICOCELE

BY JOSÉ LONDRES, M D

OF RIO DE JANEIRO, BRAZIL

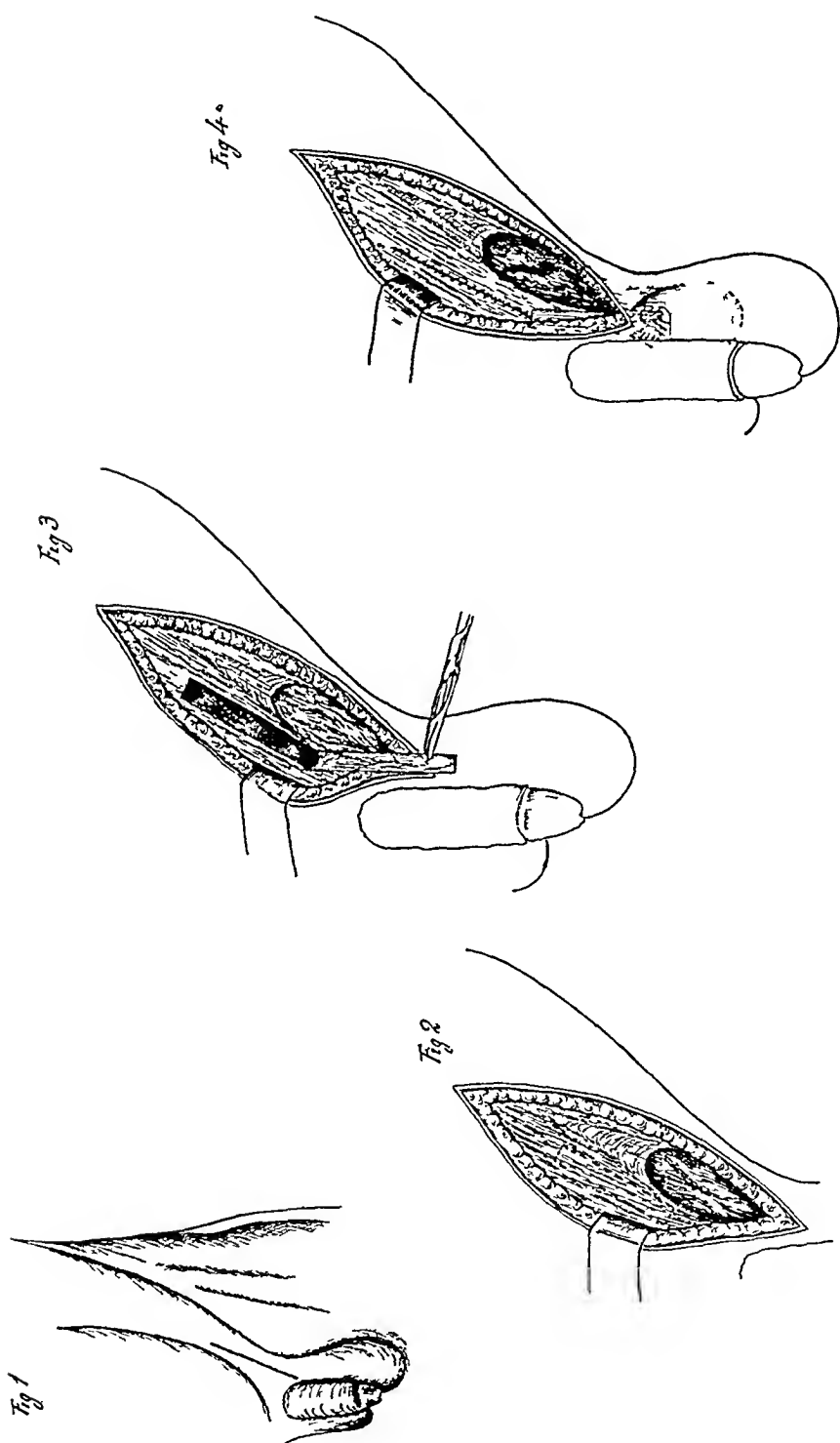
SURGEON OF THE CENTRAL NAVAL HOSPITAL

THE striking number and variety of therapeutic procedures resorted to in the treatment of varicocele are not in keeping, in our opinion with the large number of cases of this affection, which should unquestionably warrant the following of a uniform set of guiding principles for its treatment. In military circles, this fact is of particular importance since varicocele is a frequent cause of disability, and surgical treatment is of paramount importance. Some surgeons prefer the radical operation, while others are opposed on general principles to operative interference in exceptional cases only.

The operations usually performed can be placed in two groups (1) Those designed to act directly on the varicose veins of the pampiniform plexus, and (2) those which seek to promote a simple suspension of the varicose plexus either by resection of the scrotal sac, or by the simple suspension of the testis.

Lecene believes that one should not operate on the varicocele and that, even in those cases in which special circumstances require surgery, an extensive section of the scrotum should be done avoiding resection of the veins as much as possible. When, however venous section is absolutely necessary, he advocates extirpation of the anterior venous plexus and fixation of the lower stump to the inner pillar of the external inguinal ring. Because of the blood stasis, all authors advocate the simple suspension of the testis, either with or without the associated ligation or extirpation of the veins. Our experience with a considerable number of cases of all kinds has led us to adopt a uniform procedure, from which we depart only on special occasions. Suspension of the scrotal sac by means of suspensories, as advised by most authors, is a practice which should be abandoned as unsanitary and ineffectual. We are in favor of conserving the varicose veins, because their excision often increases impotence if it already exists, and may give rise to atrophy of the testis or hydrocele.

The method adopted by us consists, therefore, in a suspension of the testicle, by means of an operative technic which is easy, quick and apparently harmless and which, more than any other procedure offers possibilities for an efficient suspension. The ample section of the scrotal sac is a common procedure its effects are nevertheless transitory and the distention of the scrotum quickly recurs. Fixation of the testis to the inner pillar by a silk or any other kind of ligature is followed by one of the two following alternatives either the testis remains directly attached to the pillar and may suffer the consequences of compression against the ischiopubic ramus or it will have



been pushed down and held just below this bony structure supported by the ligature, which when absorbed allows the testis and the varicose plexus to return to their original position. The technic of the fixation of the testis by means of the inverted tunica vaginalis gives rise to the same disorders, in addition to requiring the forced eversion of the tunica vaginalis, without any more lasting results.

These facts have led us to adopt the following method, the efficiency of which has been tested in a large number of cases. This consists in suspension of the testicle by means of a flap cut from the fascia of the external oblique muscle (Figs 1 and 2) which is folded downwards, its pubic insertion remaining attached (Fig 3) and its loose end being fixed to the testicle, just below the ischiopubic bone (Fig 4). The resistance of the strip of fascia, together with the fact that it will not stretch, guarantee the lasting suspension of the varicose veins, and counteract the distention due to dependency, thus decreasing stasis and presenting all the advantages afforded by suspension of the scrotal sac, but in a safer manner. The opening made in the fascia of the external oblique is sutured (Fig 4), after one has assured himself that the external inguinal opening has retained a proper diameter. (Illustrations by Salvador Oliveira.)

GENITO-ANO-RECTAL LYMPHOGRANULOMATOSIS OF THE MALE

BY WALDEMAR E. COUTTS, M.D.

OF SANTIAGO, CHILE, S.A.

FROM THE SOCIAL HYGIENE DEPARTMENT OF THE CHILE PUBLIC HEALTH SERVICE

DURING many years after the studies of Larsen, and especially of Fournier, inflammatory strictures of the rectum were considered to be of syphilitic origin (ano-rectal-syphiloma). The absence of syphilitic infection, the negative serological tests in most patients and the inefficacy of anti-syphilitics in the treatment of this condition, awakened suspicions as to the true importance of syphilis as an etiological factor. The formation of abscesses and fistulæ in the perineal and para-anal regions, and the discovery of giant cells in the inflamed tissues gave origin to the tuberculous theory, which could not hold its own and was very soon substituted by the gonorrhœal theory (ano-rectal gonorrhœa). The absence of gonococci in the purulent rectal secretion determined a new change in the manner of estimating this syndrome and great importance was awarded to the traumatic factor, due to anal coitus. Much has been said also about dysentery, often mentioned as a cause of stricture of the rectum, but the number of cases that can be attributed to it are very few. The influence of chronic constipation cannot be accepted in males, neither can that of hæmorrhoids.

In 1925 Frei and Koppel¹ had the idea of studying the ano-rectal syndrome following esthiomena vulvæ, in relation to lymphogranulomatosis venerea and were able to establish that patients suffering from this condition reacted positively to the intracutaneous injection of their specific antigen. In rapid succession Barthels and Biberstein,² Jersild,³ Nicolas,⁴ De Gregorio,⁵ Seneque,⁶ Fischer,⁷ Langer,⁸ Bensaude,⁹ De Wolf,¹⁰ Sulzberger,¹¹ Vízcarondo¹² and many others confirmed this hypothesis, based both on histological and clinical findings.

Most authors who have studied the ano-rectal syndrome have done so in women, we have confined ourselves to the investigation of this problem in men. Up to the moment we have had the opportunity of studying seven such cases, four have been personally and carefully examined by us, the remaining three by Mr. Ramirez, following our instructions, in hospitals of Valparaíso (St. Augustine and Naval Hospitals), and whose history and evolution we have analyzed. All seven cases have been tested with the antigens prepared at our laboratories.

From our study and analysis of these cases we have arrived at the conclusion that this syndrome presents two forms in men: one that begins with the appearance of abscesses and fistulæ in the lower perineum, which are not in relationship to the urethra, and where the ano-rectal symptoms appear some years afterwards, and another, where the fistulæ appear when the

rectal stricture is already established and can be diagnosed by a simple digito-rectal examination

Judging from these facts, it would appear that the site of penetration of the virus would be different in each case. In the first form we must accept the posterior urethra as the possible place of entry, in the second, the anus or the rectum. The posterior urethra drains through lymphatics running in the lax perirectal tissues into the deep iliac lymph nodes, the anal canal developing from the proctoderm has a lymphatic system which drains downward from the mucocutaneous line through the perineum into the superficial subinguinal group of glands.

On the basis of our actual knowledge of the lymphatic distribution of the genito-ano-rectal zones, it is extremely difficult to explain how one form blends into the other. We must therefore accept that this is possible only because of the existence of up to the present undetermined lymphatic anastomosis, as otherwise we could not satisfactorily explain the production of stenosis in the absence of primitive inflammatory lesions of the anus or rectum. It might also be possible that the virus reaches the peri-anal and perirectal tissues through the minute intradermic lymphatics of the skin surrounding the anus, because when we inject this network of minute lymphatics with an isotonic solution of Grubler's methylgün and observe their course under the skin microscope, we can see them joining each other and forming larger afferent collectors, that drain towards the anal orifice*.

In the first form, which for a better understanding we will henceforth call perineo-rectal lymphogranulomatosis, the patients we have studied, two in number, do not remember having experienced any special symptoms prior to the appearance of abscesses and resulting fistulae. Both had suffered from gonorrhoea, neither from syphilis. One had ailed from a double inguinal lymph-node inflammation, following a small ulceration of the penis which was opened surgically and took several months in healing. In relation to the syndrome we are describing, the first symptom they observed was the appearance of one or more fluctuating masses, followed at varying intervals by others, in the upper, middle or lower perineum. These abscesses were painless, broke out spontaneously, leaving fistulae through which carrying quantities of sero-pus flowed constantly. During this period it is very easy to attribute to the fistulae a urethral origin (peri-urethral abscess), more so if the patient has a former history of gonorrhoea and a wide urethral stricture. But it is interesting to note that the patients have never noticed the passage of urine through them and that micturition under pressure, when the bladder is full of a colored solution, is incapable of forcing liquid through them. The rectal symptoms appear later and are at the beginning of a sordid nature.

Following are the summarized clinical histories of both cases

* The existence of these minute skin lymphatics and their importance has been recently demonstrated by Hudack and McMaster (Jour of Exp Medicine vol LVII No 5, 1933)

CASE I—J A G, twenty-nine years of age Family history of no importance Personally he has always enjoyed good health In 1920, gonorrhœa for the first time In 1928, he experienced slight micturitional difficulty, two months afterwards a small abscess appeared in the middle perineal region to the right, followed by several others that at varying intervals broke out all over the perineum and para-anal zone (Fig 1) Patient has never noticed urine passing through the resulting fistulæ Clinical examination made in March, when he entered one of our wards, revealed clear urine with some filaments Wide stricture in the bulbar portion of the urethra Digito-rectal examination and proctoscopy negative Wassermann and Kahn tests negative Ito von Reenstierna negative Frei with A antigen positive after twenty-four hours, positive after forty-eight hours Skin allergy towards B antigen negative⁺ Controls with aseptic milk, sterile leucocyte suspension and physiological salt solution, all negative



FIG 1—Numerous fistulæ opening on the perineum and around the anus, none of them in communication either with urethra or rectum. (J A Ward, San Francisco Bed 11, Clinical Hospital, Medical College, Santiago, Chile, 1933)

CASE II—E B, twenty-eight years of age Family history of no importance Seven of a family, one died in early childhood In his youth he suffered from left otitis, although Wassermann was negative at the time he was given antisyphilitic treatment At the age of nineteen years, chancre complicated by double inguinal lymph-node inflammation, which was surgically opened and took several months in healing At the age of twenty-three, new gonorrhœa which was complicated by prostatic abscess and total urine retention Abscess was not operated and opened spontaneously into the posterior urethra Two and a half years ago he entered one of our wards complaining of perineal and peri-anal fistulæ, which shortly after their appearance were accompanied by diarrhœa muco-purulent and hæmorrhagic stools which subsided after adequate treatment

Examination at the time revealed a wide calibre stricture of the posterior urethra chronic prostatitis and numerous fistulæ in the middle and lower perineum Several scars could also be seen in the same regions Rectal examination was normal, Wasser-

* The significance of A and B antigens can be found fully explained in our article "Skin Allergy and Lymphogranulomatous Antigens," published in Archives of Dermatology and Syphilology, 1933

MALE GENITO-ANO-RECTAL LYMPHOGRANULOMATOSIS

mann and Kahn tests negative. He remained under our care for over two months and was submitted to a series of dilatations and both local and surgical treatment of his fistulæ, nevertheless when he left the ward he was in about the same condition as when he entered.

For a period we lost sight of him, during which he attended different hospital out-patient departments, submitting to all manner of treatments, but never noticing any improvement of his fistulæ. Symptoms of constipation have been present and during the last months proctitis has been predominant. In May of the present year he again entered one of our wards. The perineal and peri-anal fistulæ presented the same aspect as when first examined by us (Fig 2). Digito-rectal examination revealed the existence of a stricture that begins immediately over the anus and extends upward through the rectum, narrowing progressively. Bacteriological and parasito-



FIG 2—Anal excrescences, perineal and peri-anal fistulæ, some of the latter in communication with the rectum. Scars that correspond to fistulæ not in activity at present (E. B. Ward, San Francisco, Bed 21, Clinical Hospital, Medical College, Santiago, Chile, 1933.)

logical examination of rectal secretion negative. Proctoscopy confirms the existence of chronic proctitis of the ulcero-proliferative type with a stricture that extends for about 12 centimetres from the anal portion upward (Fig 3). Biopsy of several samples of this stricture shows the existence of connective tissue, mostly fibrous in nature, with numerous superficial hæmorrhagic zones and ulcers. Urethra free in all its length to a nineteen-calibre Mercier catheter. Urine clear. Wassermann and Kahn tests negative. Skin allergy toward A antigen positive ++ after twenty-four hours and positive +++ after forty-eight. Ito von Reenstierna negative. Controls all negative. Clinical radiological and radioscopical investigations as regards the possible existence of tuberculosis of lungs, all negative.

The other form, which we will denominate ano-rectal lymphogranulomatosis seems apparently to develop in a latent form, in some cases occasional feeling of rectal fullness with slightly painful discharge by the anus of mucus. Once the stricture is established, movements are difficult and several days elapse between one evacuation and another, patients must use cathartics or enemas. Rectal suppuration, of varying intensity appears. Symptoms of stricture rapidly predominate and there is intense and persistent consti-

pation. Fæces change their shape and are evacuated in flat pieces. After a varying period of time in each case, the stricture is complicated by abscess and resulting fistulæ, which, in the great majority of cases, are the cause that determine the patient to consult a physician. On examination, around the anus there can be seen small and hard condylomatous excrescences, the skin is pachydermatous and sometimes small papillomatous strips follow the anal folds. Digito-rectal examination reveals just beyond the anus or immediately above thickening of the wall and loss of elasticity, small vegetating proliferations and a progressive narrowing which renders the examination painful. Proctoscopy shows a dark red, uneven mucous membrane with cicatricial spots, vegetations, hæmorrhagic zones and ulcers. As we approach the narrower portions the stiffness increases and the gray color of the surface contrasts with the mucous membrane lower down.

Of the five cases analyzed, two studied by us and three by Mr. Ramirez two had positive blood tests for syphilis (40 per cent). Following are the summarized clinical histories of our two cases.

CASE III—A. B. L., twenty-six years of age. Family history of no importance. He has suffered of diseases common to early childhood. In 1924, chancre that healed spontaneously in eight days. Since 1929 he noticed symptoms of constipation that increased gradually, occasionally four days elapsed between one movement and another. This same year he was operated simultaneously for appendix and right hernia. Wassermann was negative at the time. In 1930 a small abscess appeared on the right peri-anal region, that was surgically opened and healed apparently during three months, when a new abscess formed, resulting in a fistulæ that persists up to the present moment. In the beginning of 1932 symptoms of proctitis set in, patient suffers occasionally from frequent and painful muco-purulent stools. At the time he notices that the feces are ribbon-shaped.

Examination revealed a left inguinal hernia. No signs of tuberculosis can be found either clinically or radiologically. Genital organs normal. Around the anus there exist several condylomatous excrescences. No stricture in the urethra. Prostate cannot be felt owing to the existence of a stricture that begins immediately over the anus and extends upwards (Fig. 4). The surface of the palpable portion of the stricture is covered by hard, proliferating masses. Proctoscopy reveals the existence of a chronic proliferating proctitis and a stricture that cannot be explored in all its length owing to its density and pain. Microscopical examination of a biopsy of this region reveals a considerable fibrous infiltration of the submucosa. Wassermann and Kahn tests, negative. Skin allergy toward A antigen intensely positively, negative to B antigen as well as usual controls.

CASE IV—J. L. N., nineteen years of age. Family history of no importance. In early childhood he suffered from a severe attack of gastroenteritis. In 1930 gonorrhœa and multiple chancres of the prepuce, complicated by a right inguinal bubo, which had to be surgically drained. Twenty days ago he noticed urethral discharge which increased rapidly. He consulted a physician because his right testicle had recently become painful and swollen. This physician on trying to examine his prostate, discovered the existence of a stricture and sent him to me for further examination. Careful interrogation established that for about two years he had suffered occasionally from painful hæmorrhagic movements and that lately the fæces had acquired the shape of tape-worms. Constipation has not been a predominant symptom, sometimes he has passed as many as two days without evacuating.

My examination confirmed the existence of an acute antero-posterior gonococcal

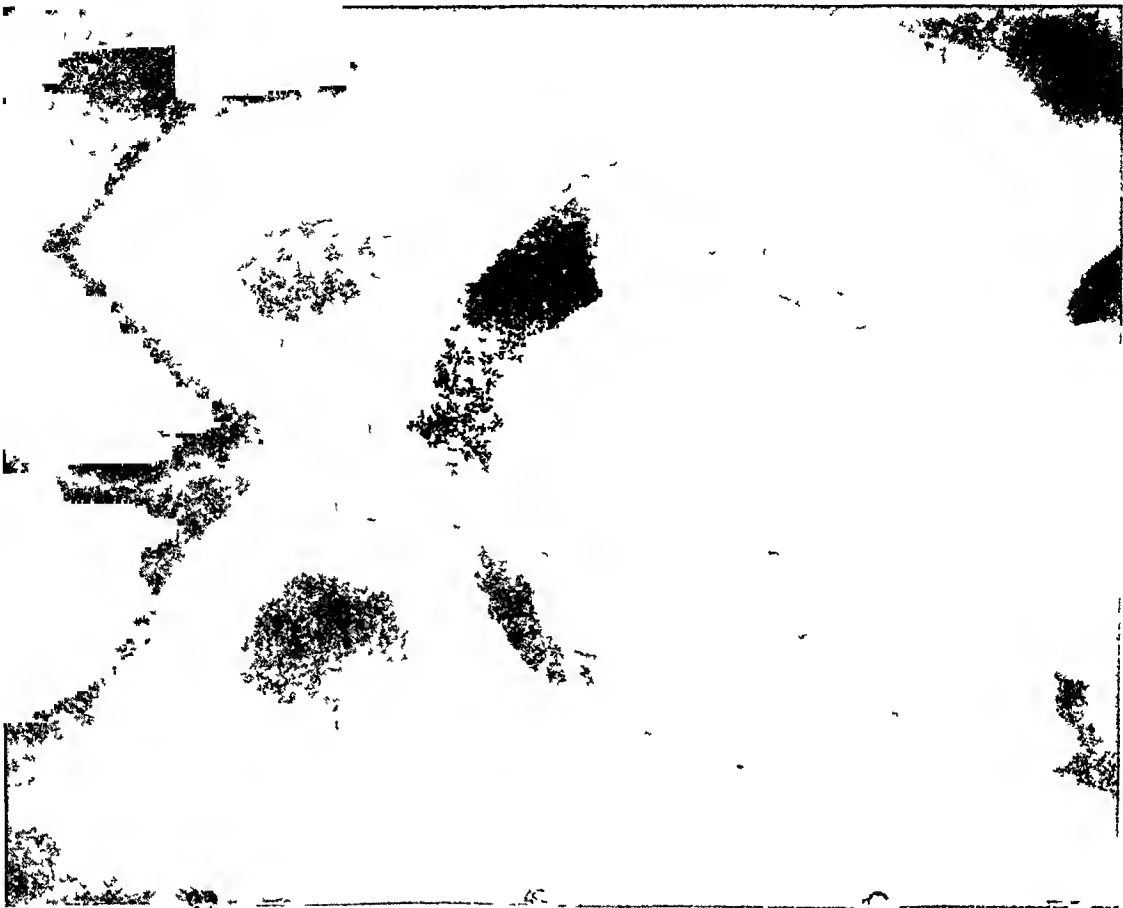


Fig 3—Radiogram after bismuth enema showing dilated bowel and stricture of ileo rectal region



Fig 4—Radiogram after bismuth enema showing very marked structure of the rectum

urethritis and a right epididymis deferentitis. Digito-rectal examination was very painful and confirmed the existence of a stricture beginning immediately over the anus, narrowing gradually upward and impeding the total introduction of the exploring finger. The rectal mucous surface was irregular and presented numerous papillomatous growths. A hard lymph-node mass had appeared three months ago, in the right cervical region which presents no adhesions with the surrounding skin. Examination negative as regards lung tuberculosis. Frei's intracutaneous reaction with A antigen was positive after twenty-four hours, B antigen reaction and controls negative. Wassermann and Kahn tests were both negative. The patient refused proctoscopy and did not present himself again to our department.

In all four cases we have performed our complement fixation reaction employing as antigen a 1 to 30 solution of pus from inguinal lymphogranuloma cases and obtained in all of them positive reactions.

In relation to this syndrome it is interesting to remark that in only one out of the seven cases the age of the patient was over thirty years. As up to the present moment the prognosis of this condition is very obscure, judging from general experience in women we must join our efforts in order to discover the means of preventing this new venereal disease which menaces mankind.

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RESTORATION OF HAND FUNCTION AFTER TRAUMATIC INJURY*

BY JOSEPH E. FULD, M.D.
OF NEW YORK, N. Y.

MANY of the crippling deformities resulting from injuries to the hand could be avoided if the proper initial operative and post-operative treatment were used. Injuries to the hand are among the most common conditions with which a surgeon has to deal. It is surprising, however, that the surgeon who does skillful work in other departments of surgery often fails to get equally good results in his work on the hand.

From the standpoint of treatment, injuries of the hand may be divided into the following groups: (1) Injuries requiring immediate repair, (2) injuries necessitating final restorative treatment. In cases where there has been a loss of soft tissues with contractures, especially on the palm, and flexure surface of the finger, a pedicle skin graft should be used. This graft may be taken from its most adaptable location, *viz.*, from the abdomen, thorax, back, thigh or buttocks. The pedicle skin graft is the only type which promises permanent results, because of the excellent pressure-bearing surface it provides.

There are certain principles which are necessary to observe in the treatment of these cases if a successful final result is to be obtained. Since each principle in its particular way, and all combined are so interdependent, the non-observance of any one principle will diminish the value of the others.

- (1) All scar tissue must be removed and the skin edges undermined.
- (2) The surrounding skin which has been under tension will then contract to its normal state.
- (3) All hematomata should be avoided by hemostasis, brief drainage, and gentle prolonged pressure.
- (4) Immobilization and avoidance of any raw area are essential to accurate healing.
- (5) A skin-pedicle graft should not be under tension; otherwise gangrene of the graft may set in.
- (6) To insure a viable pedicle graft, the span or flap should be approximately three times the width of the pedicle and should be cut at least one-third larger than the area to be covered, as there is always immediate shrinkage of the flap.
- (7) The selection of the skin to be transplanted must be made with some regard to the character of the skin surrounding the area that needs to

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be covered, *e g*, the selection of hairy skin should be made to cover the defect in a hairy area of the body

- (8) The sooner the operation can be performed after an injury has been sustained, the better. If possible, it should be performed before the trophic changes have taken place in the joints

When there exists a defect in the skin or soft parts, this defect may be overcome by the use of any of the accepted skin grafts, *viz*, (1) Thiersch graft, (2) pinch or pedicle graft, (3) Wolfe or whole-thickness graft. These grafts are to be used according to the indications in each case

Thiersch Graft—(1) Thiersch skin grafts are valuable in covering over superficial raw areas on the dorsal surface of the hand and between the fingers, since this type of repair lessens contractions and prevents infections which otherwise would be more apt to occur. They have the advantage of being easily obtained and of taking readily even in the presence of a mild infection

The disadvantages of the Thiersch graft are that

- (1) They cannot be used on the flexor surfaces of fingers or hand as they bear pressure poorly, (2) they undergo shrinkage

Before applying Thiersch grafts, the skin surface is prepared, as for operation, by cleansing with soap and water only. Antiseptics are not to be used

The graft may be cut quite satisfactorily with an ordinary straight razor, a special skin-graft instrument is unnecessary

Strips of sterile adhesive plaster are used for covering a fixation of the grafts, taking care to leave a space for the escape of the wound secretion into the gauze dressing. The adhesive-plaster strips should be changed once in ten days but the gauze should be changed every three days

Pinch Graft—(2) The pinch graft is a deep skin graft that is used to hasten the healing of granulating wounds. It is obtained by snipping minute bits of skin from any skin surface and applying them to the surface which is to be covered with epithelium. This method is most successful to hasten healing of raw granulating surfaces, thus minimizing the danger of infections and contractures. Here again fixation of the graft is a procedure of vital importance. The method described for Thiersch graft should be followed. It is important to remove pressure compression caused by the gauze dressing, by removing the gauze every three days. The skin defect produced by removal of the graft should then be closed with a suture

Wolfe or Whole-Thickness Graft—(3) The Wolfe or whole-thickness graft utilizes the entire thickness of the skin. This is a very pliable graft and resembles in appearance the surrounding skin, and does not undergo so much shrinkage as does the Thiersch graft. It should be used to cover fresh wounds. The Wolfe graft is not adaptable to granulating wounds as are the pinch and Thiersch grafts. "Taking" of a graft depends upon the nourishment of the tissues immediately beneath it. The Wolfe graft

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should be cut to the exact size of the defect that is to be covered. Its success will depend upon four factors

- (1) There must be accurate coaptation of the edges of the graft with the skin margin of the defect to be closed, (2) all subcutaneous fat should be removed from the graft, (3) mild pressure on the graft by means of

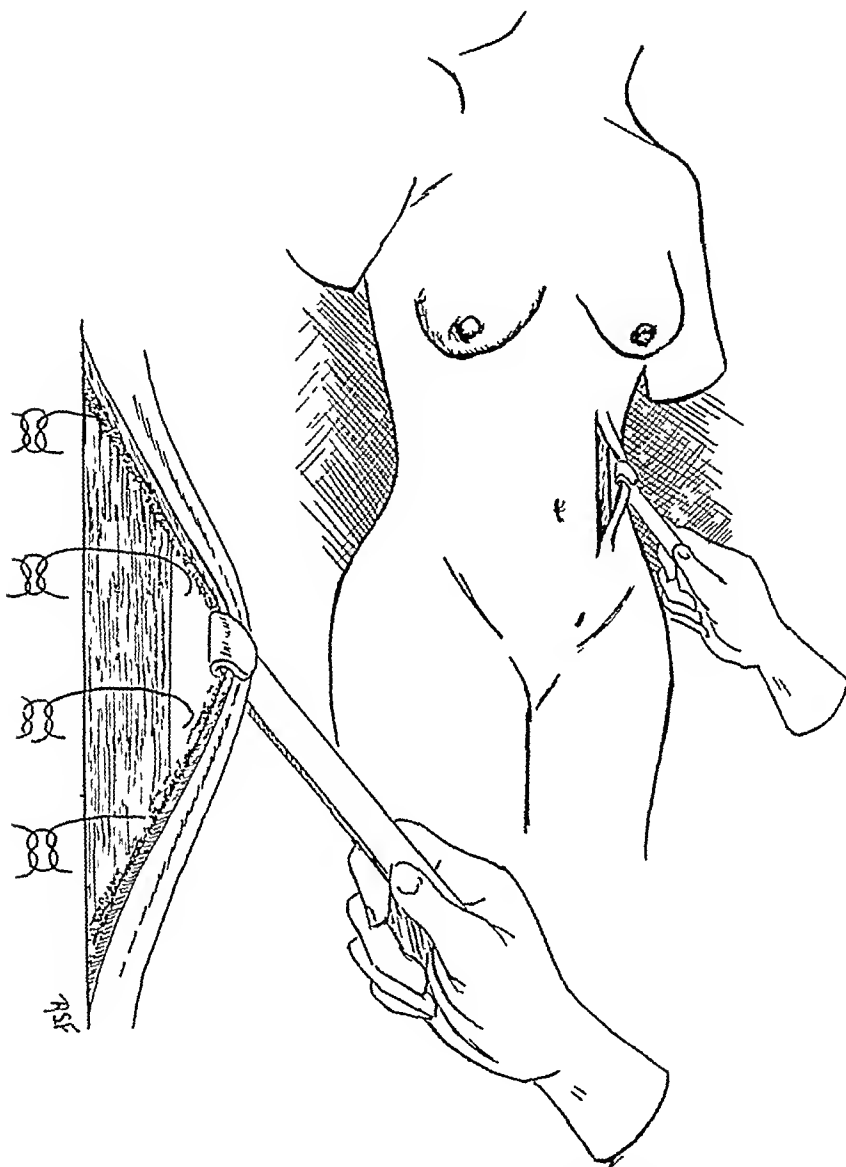


FIG. 1—(Right) Skin graft freed above and below and raised by retractor showing sutures for closing of the wound behind the graft. (Left) Sutures tied, bringing the skin edges together beneath the elevated pedicled graft.

a rubber sponge should be maintained for two weeks, and (4) complete immobilization of the hand must be established for about three weeks

Pedicle Graft—(4) Where there is a great deal of destruction of the skin and subcutaneous tissue, causing deformity and marked disability of the hand, and a pressure-bearing surface is desired to cover the defect on the hand, a pedicle graft is indicated. This method of treatment has given universally good results in plastic surgery on the hand.

There are three types of pedicle grafts (a) Tubular graft or rope graft, (b) single pedicle graft, and (c) double pedicle or pocket method

Tubular Grafts—(a) Of the three types of pedicle grafts, the tubular graft is preferable because it lacks the raw surface that is present with the ordinary pedicle graft and offers less opportunity for infection. As a result of the infection which occurs when non-tubular grafts are used there often follow disfiguring scars and keloid formations. Similar to incisions used for drainage, the borders of tubular grafts should run in a line parallel with flexion creases. The tubular graft method consists in preparing the pedicle by making two parallel incisions from two to three inches apart and in rais-

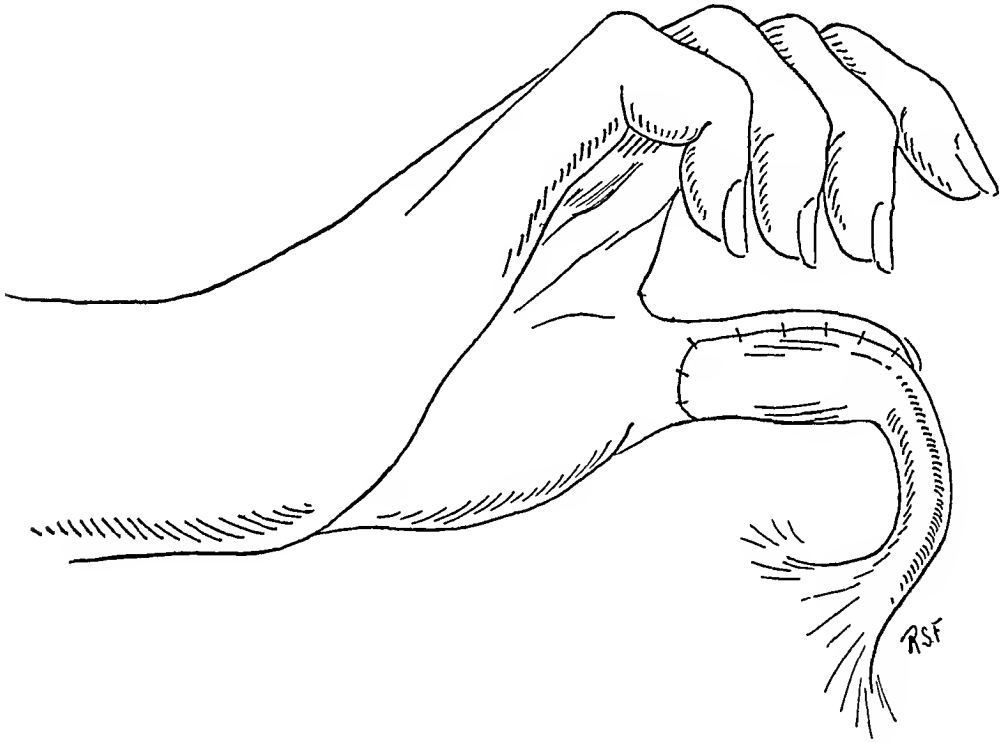


FIG 2—Tubular pedicle graft. Method of relieving marked flexion deformity by the substitution of good pliable skin in tubular pedicle graft in place of cicatrix.

ing the skin between them. The defect in the skin is then closed by bringing its edges together (Fig 1). We then suture together the parallel edges of the pedicle so that it assumes the form of a tube with the skin surface outward. The tubular graft has very little raw surface exposed, consequently the graft remains much cleaner. The pedicle should be made loose to allow free circulation (Fig 2). The tension should be that of normal skin. The hand must be kept absolutely immobile. Split-tube drainage, vaseline gauze or rubber dam should be placed between the skin tube and the underlying skin wound for the first thirty-six hours. Mild pressure is employed when dressing the wound to prevent hematoma. In about two or three weeks the skin continuous with the distal end of the tube should be raised and cut to pattern required and then transferred to fill the defect which is

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to be covered. About two or three weeks later, the proximal end of the pedicle is cut off at its base and sacrificed.

The Use of the Tourniquet in Surgery on the Hand—The use of the tourniquet in most operations on the hand greatly facilitates the surgical procedures. With the use of the tourniquet, one operates in a dry field and is better able to recognize the anatomical structures and thereby reduce the time required for such an operation. If the proper tourniquet is used, and if it is correctly applied and not allowed to remain on the arm for more than one hour, there will be very little danger to the tissues. The best tourniquet is a rubber bandage about three inches wide. It should be placed around the lower third of the arm, it should never be applied to the middle third of the arm lest it cause damage to the musculospiral nerve. Before applying the tourniquet, the arm should be elevated and the blood in the hand and forearm milked out by massaging toward the shoulder. Then the bandage is wound several times loosely around the arm to prevent it from cutting in and injuring the arm. Finally it is rapidly wound tightly and the last loose end is placed under a loop in the bandage to hold it in place. In this way the veins will not have time to refill and therefore, when the tourniquet is properly applied, the limb will have a cadaverous aspect, being entirely devoid of blood.

The tourniquet should never be allowed to remain on for more than one hour, because too long an ischæmia will provoke a generalized tissue reaction, which again results in a degree of firm induration of the parts similar to the condition of Volkman's ischæmia. It is safer to divide the operation into two or more stages, as the amount of work one can accomplish on the hand in one operation is limited by the time it is safe to maintain ischæmia by the tourniquet.

Functional injuries of the hand may be divided under four headings: (1) Injuries of the skin and subcutaneous tissue, (2) injuries to the tendons, (3) injuries to bone and joints, (4) injuries to the nerves.

SKIN AND SUBCUTANEOUS TISSUE—In group 1 plastic surgery plays a very important rôle in the treatment of contractures of the hand and fingers. While contractures may follow avulsions of the skin, they usually follow an infection or a misplaced incision that crosses a flexion crease at right angles.

The prevention of contractures is one of the fundamental objectives in hand injuries. Contractures result from injuries to tendons or nerves that have not healed properly, or from scar-tissue formation in the skin. Primary suture of the cut tendons or nerves will give better results than late repair. During the process of healing, the finger and wrist must be put into the best functional position if ankylosis is anticipated. The hand is practically worthless if the wrist is fixed in the straight position or in palmar flexion. Only when the hand is fixed in dorsal flexion will it be useful. This is particularly true where opposition of the thumb and index finger is not possible, if the

fingers are extended and the thumb abducted. It is not advisable to wait for spontaneous healing of large, raw surfaces, which result from burns or crushing injuries. If such surfaces are covered at the earliest possible moment with skin grafts, time is saved for the patient, the constant danger of reinfection is eliminated and scar-tissue formation is reduced to a minimum. Early mobilization of the fingers and wrist should be the rule to follow.

Prevention of Contractures and Stiff Fingers—As a factor in preventing stiff fingers, the importance of properly placed incisions for drainage in infections of the hand cannot be too strongly emphasized.

It is also necessary as soon as the acute symptoms have subsided to actively and passively move every finger-joint in order that drainage be facilitated and the formation of adhesions be prevented, because the longer the infection lasts, the greater is the growth of granulation tissue and consequently the greater the eventual cicatricial contraction. In changing the dressings asepsis must be maintained. The hand should never be allowed to become waterlogged by the prolonged application of wet dressings. After the first dressing which takes place about the third day after the operation, every morning and evening, the hand and forearm should be soaked for about ten minutes in a sterile bath of normal saline solution. After the bath, the hand is laid on a sterile towel for about thirty minutes under an electric lamp. Then the hand is dressed with gauze moistened with 5 per cent Balsam Peru in castor oil.

Secondary Effects of Contractures—In skin the irritation of the scar from intermittent tension results in keloid formation. Thus, where a scar crosses a flexion crease, every effort of extension tends to increase the keloid formation and this, in turn, the contractures. The same is true of the deep cicatrix for connective tissue and in some people more than in others. Muscle balance is upset. While one group of muscles is over-stretched and weakened, the opposing group is allowed to contract and become fixedly so. Secondary contractures result.

Dupuytren's Contraction—While the etiology of Dupuytren's contraction is obscure at the present time, successful treatment exists. The deformity consists of a permanent flexion of one or more of the fingers due to a contraction of the palmar fascia and its digital prolongations. It is a recognized fact that the treatment for Dupuytren's contraction is surgical. The method which gives the most excellent results is excision of the palmar fascia with a pedicle graft to fill the defect.

Technic—The parts are thoroughly cleansed with soap and water—no antiseptic is used. A T-shaped incision on the palmar surface of the hand is made. This incision gives a good exposure of the whole aponeurosis. The transverse part of the incision is made along the distal palmar crease. The lower part of the T is made at right angles with its horizontal top and reaches the base of the wrist. The skin is then undermined on all sides exposing the entire palmar fascia starting from the proximal portion.

Dissect the fascia en bloc up to its digital ramifications. All the hope-

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lessly affected skin that was adherent to the fascia is removed. The skin defect is filled in with a pedicle skin graft. The wound is dressed with the fingers in full extension.

The post-operative treatment is a long, painstaking one. Two weeks after the operation, massage—active and passive—and exercises of the fingers are begun.

Volkman's Ischæmic Contracture—The deformity present in Volkman's ischæmic contracture is palmar flexion of the wrist, hyperextension of the metacarpophalangeal joints and flexion of the phalangeal joints.

The etiology of Volkman's contracture is principally compression of the soft structures on the flexor surface of the forearm. The deep fascia of the flexor aspect of the forearm, together with the bones, and the interosseous membrane, constitute a tough wall of an enclosed space incapable of expansion. When swelling occurs due to extravasation of blood and fluids into this space, the pressure exerted, first affects the muscles most, but the nerves and other structures are not spared. After the initial intense inflammatory reaction and absorption of products of necrosis, contracting fibrosis occurs. The muscles undergo fibrous degeneration and are shortened. All tissues are bound together in the cicatrix and the nerves are damaged and strangled, resulting in paralysis and atrophy.

Treatment—The following conservative method advised by Robert Jones is the most effective. It consists of making constant use of mild traction which will draw stiff joints into functioning positions, elongate soft cicatrices and contracting muscles.

(1) The first procedure is to passively flex the wrist to allow the fingers to extend, each finger is strapped to a finger splint in extension.

(2) A day later attempt is made to extend the phalangeal and the metacarpal range by means of a metal splint, the wrist being allowed to remain flexed.

(3) The next step is to daily extend the wrist a little farther, the improved position being held by the splint. This process is continued until the wrist is dorsally flexed. Hyperextension of the wrist and fingers is maintained for about six weeks.

INJURY TO THE HAND WITH AVULSION OF SKIN OF THE PALM AND FINGERS

CASE—A man, aged forty-two years, caught his right hand in a sandpapering machine. The skin and the subcutaneous tissue of the entire palm and the flexor surface of the thumb, fourth and fifth fingers were torn off exposing the flexor tendons. The wound was not sewed. A vaseline dressing was applied by the physician then in charge. Flexion contraction of the thumb, third and fourth fingers developed. The fingers and thumb could not be extended voluntarily or passively, because of the resistance of the scar-tissue contraction on the flexor surface. This is one of the most unfortunate conditions which one can encounter in the hand, owing to the cicatricial contraction which follows laceration of the palmar structures. The excessive formation of connective tissues here is a quite regular occurrence with the production of a dense scar. The usual places where similar scars may form are on all flexor surfaces, in the neck, in the

fold of the wrist, elbows, popliteal space, *etc*, because they are subjected here to frequent repeated extension and flexion

Treatment requires first, the dissection away of all the scar tissue. The next step was to undermine freely the edges of the wound, then fill in the defect left from the scar excision by a slightly larger piece of normal skin. Such a piece of skin was secured in this case by transplanting a pedicle flap from the front of the abdomen which had been surgically prepared. The arm and hand were immobilized across the

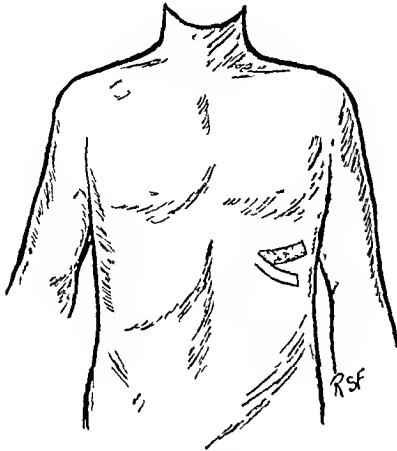


FIG 3—Showing the free end of the pedicle graft raised from the abdominal wall

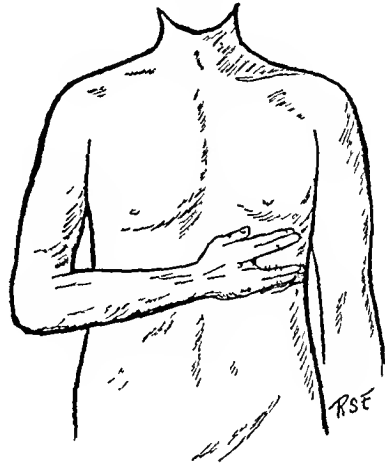


FIG 4—Showing the free end of the pedicle graft sutured to the fingers

body in a comfortable position with a wide strip of adhesive plaster. The hand and arm must be kept perfectly still for fifteen days after the operation. Under local anaesthesia on the fifteenth day the pedicle of the flap was entirely severed and the hand released from the abdomen. The cut edges of the flap bled freely, which spoke well for a successful outcome. The freshly cut edges were now sutured to the hand and a dry dressing applied.

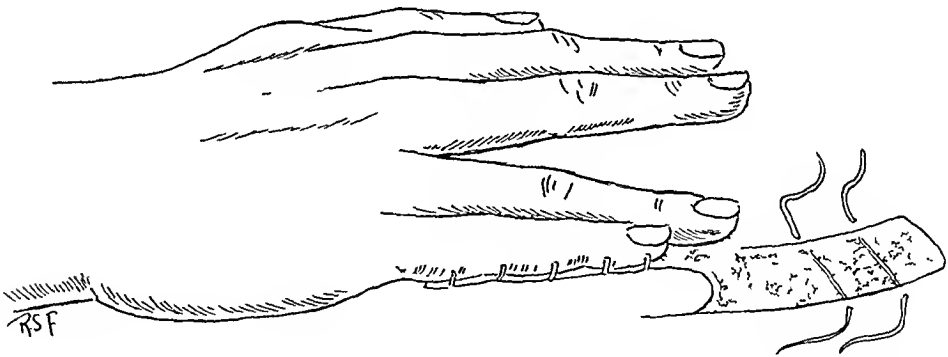


FIG 5—Showing the pedicle flap from the abdominal wall sutured to the fingers. The sutures for closing the wound when tied bring the skin edges together beneath the elevated flap

Result—The patient was able to flex and extend the fingers. The hand grip was strong. The skin in the palm was entirely covered and gradually the transplanted skin flap became toughened to meet the demand for pressure placed upon it, resulting finally in a very excellent pressure-bearing surface in this tender tissue.

Second Operation—The scars on the flexor surface of the finger not having been removed at the first operation, it became necessary to do this later, as these scars were scraped down and ulcerated when pressure was brought to bear upon them. The second operation was performed October 8, 1919. The skin of the hand and

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abdomen was surgically prepared, the scar tissue extending on the palmar surface of the fourth and fifth fingers was removed, and the edges of the wound freshened and elevated allowing them to retract away from the field so as to leave it free, thus preparing the bed for the transplant. As the skin between the fingers was destroyed at the time of the accident it was necessary to make a new web. A tongue-shaped pedicle flap (Fig 3) was made one-third wider than the width of the fourth and fifth fingers with the pedicle upward including the entire thickness of the skin and a little of the subcutaneous tissue from the side of the abdomen and infracostal region (Fig 4). The patient's hand was now placed on the abdomen and the skin edges of the hand wound were sutured to the flap (Fig 5) which must be gently handled, carefully adjusted as precision and accuracy of apposition is essential. The hand and arms were immobilized with adhesive plaster. Fourteen days later the pedicle was cut. A new web was constructed from the transplanted graft between the finger and sewed in place which healed by primary union (Fig 6).

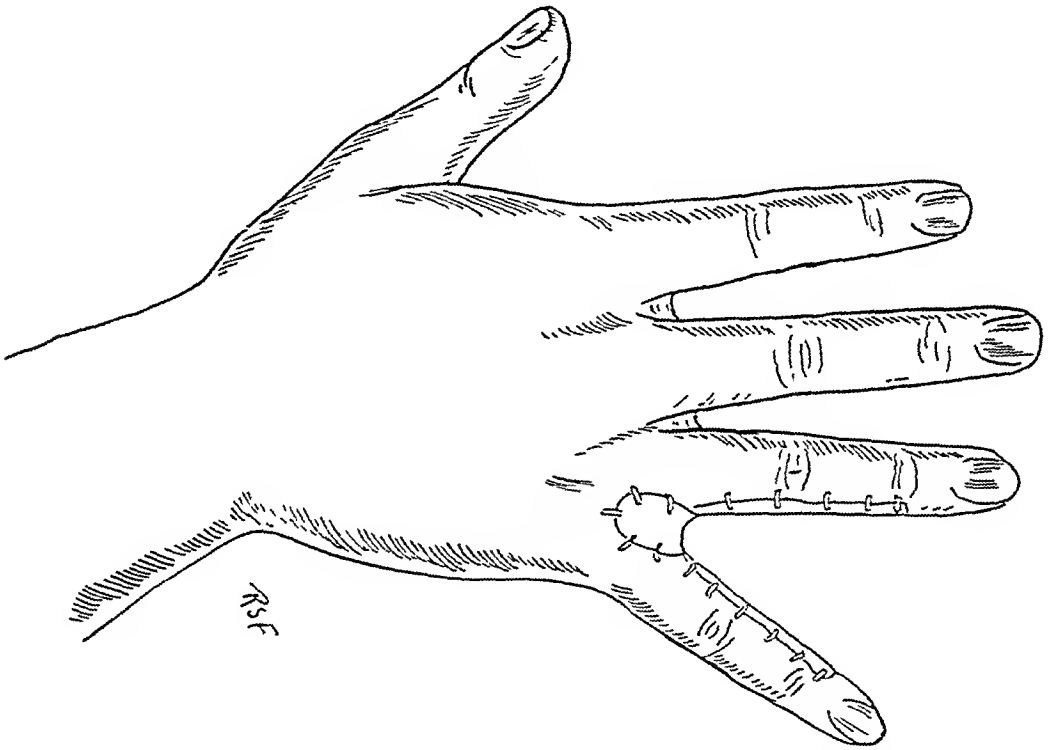


FIG 6—Showing dorsal surface of hand with new web between the fingers sutured in place also the lateral edges of the pedicle flap sutured to the edges of the fingers

Injury Involving the Dorsum of the Hand—The pocket method of closing the skin defects may be used in this type of injury. This method of skin grafting consists of raising a bridge of skin and subcutaneous tissue from the underlying aponeurosis inserting the part to be grafted (Fig 7), and fixing it there until union between the raw pedicles are cut. It is very important to take a Wassermann test and never to operate where there is an active syphilitic process. This method is indicated where it is necessary to cover large skin defects of extremities as after injuries of hand, wrist, finger or foot especially about their joints, to remove cicatrices which bind down tendons and interfere with action of muscles or their tendons and to restore flexion or extension.

CASE—A woman aged twenty years, while working in a laundry about two and a half months before her admission to the hospital had her right hand caught in a

mangle The skin and subcutaneous tissue were torn off the dorsum of the hand, exposing all the extensor tendons The wound refused to heal In addition to the skin defect, due to cicatricial contraction of the dorsum of her hand the extensor tendons were fixed, so that she was unable to close her hand This made the indications for the operation two-fold first, to cover the skin defect, and secondly, to prevent contraction

After improving her health and strength by general hygiene, dietetic and tonic measures, an operation was planned for relief by transplanting from the abdomen to the dorsum of the hand, a strip of normal skin broad enough to fill the gap left after excision of the scar tissue, binding the extensor tendons and allowing the flexor tendons to act in the closing of the hand

The skin of hand and abdomen was surgically prepared, all the cicatricial tissue was removed, then the edges of the wound were freshened and elevated, allowing them to retract away from the field so as to free the field far above and below, thus preparing the bed for the transplant

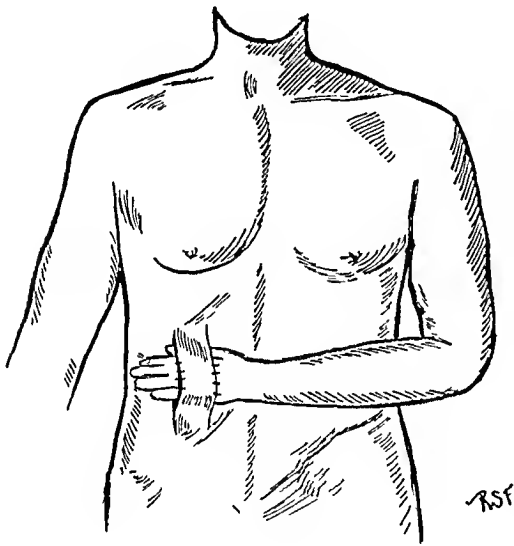


FIG 7—Pocket Method Pedicle Graft
Hand passed beneath the flap with the palmar surface facing the abdomen and the dorsum contact with under surface of the flap The skin edges of the hand are sutured to the skin graft

Two parallel vertical incisions were then made, extending from a little below the left nipple to a line on the level with the umbilicus, cutting down to the aponeurosis of the abdominal muscles, including in the flap the entire thickness of the skin and subcutaneous tissue of the abdominal wall The formation of adhesions was prevented by the fat in the flap The far edges of the wound were sutured together under this flap, so as to restore the continuity of the abdominal wall

The patient's hand was now passed beneath the flap, with the palm facing the abdomen and the dorsum in contact with the under surface of the flap The skin edges of the hand wound were sutured to the flap, which was gently handled, carefully adjusted and precisely sutured, as accuracy of opposition is essential From the natural contractivity of the skin it contracts and shrinks considerably, so it was made a third wider than the defect to be

filled, and longer than apparently necessary to avoid undue contraction of the pedicles Perfect hemostasis and strict asepsis and antiseptics are necessary to assure success The freshly cut edges were now sutured to the hand and a dry gauze dressing held in position by a bandage applied The position in which the hand was held was very comfortable Since the hand and arm had to be kept perfectly still for fifteen days this immobilization was secured by holding the arm against the abdomen with adhesive plaster Under local anæsthesia on the fifteenth day both pedicles of the bridge flap were entirely severed and the hand released from the abdomen The freshly cut edges were now sutured to the end and a dry dressing applied

Final Result—The skin defect is perfectly covered The patient is able to flex and extend his fingers The grip is strong, the æsthetic effect is marked The only scars showing are the suture lines at the union of the flap, replacing the unsightly and awkward scar of the granulating surface

The advantage of this method far outweighed the disadvantages of a two-stage operation (1) The blood supply from the two pedicles assured

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the necessary vitality (2) There was no stimulation of the connective-tissue formation and the resultant cicatricial contraction (3) The presence of fat in the flap prevented adhesions to the tendons below (4) The raw surfaces were approximated and held in position with ease (5) The two pedicles acted as splints to hold the grafted portion in position (6) At least six weeks were saved in healing time (7) The excellent pressure surface is of great advantage in this part of the body, exposed as it is to rough usage, traumatism, constant flexion and extension (8) Finally, it is the method of choice when the sliding method is impracticable

Injury to Hand with Loss of Finger-tip—In a large number of occupations, especially among musicians, the shortening of a finger even ever so little would greatly lessen its value. Conservation of function must therefore always be kept in view. For this purpose the following simple plastic operation may be relied upon to retain the original length of a finger after the loss of soft tissue by partial traumatic amputation of the terminal phalanx.

The best method of early treatment, especially when the bone is exposed, is to raise a single pedicle flap with a lateral attachment to the palmar surface of the finger near the wound. Suture it to the opposite side of the terminal phalanx providing a good pressure-bearing surface. If one allows the entire wound to heal by granulation, there would be a sensitive stump, the bone being covered by scar tissue only, while shortening the bone would naturally give a shorter finger.

CASE—A lad, aged sixteen years, while chopping meat, accidentally amputated the tip of the middle finger which was cut off obliquely a quarter of an inch beyond the wound. The wound and skin surrounding it were surgically prepared. A transverse incision was made and the flap of skin and subcutaneous tissue raised with a single pedicle attached. The free end of the flap was sutured to the opposite side of the finger. The flap lived in its entirety, the sutured edges united by primary union, and the resultant raw surface left to granulate. In fourteen days the finger had entirely healed. Amputation at a higher level had been avoided and the power of flexion at the distal joint was preserved.

Loss of All or Part of Finger—Nicoladoni was the first to describe the autoplasmic transplantation of a toe for the traumatic loss of a finger which he published in the Archives of Clinical Surgery in the year 1900. He successfully performed and described an operation in which he replaced a thumb by transplanting the second toe. Since then very few cases of successful transplantation of toes to replace lost fingers have been reported.

CASE—September 18, 1925, a man, thirty years of age, while operating a bread-slicing machine, accidentally amputated the distal third of the middle finger of his right hand. The wound being recent and clean, the case was considered favorable for grafting a toe to replace the missing finger.

The day following the injury, the patient was placed under ether and after exceptional care of the surgical field, the following procedure was carried out.

An incision was made at the level of the head of the fifth metatarsal bone, transversely across the dorsum of the small toe of the right foot, deepened through, exposing the extensor tendon. This was cut across and the bone disarticulated. The in-

cision was carried farther until the toe was left attached to the foot by only a pedicle plantar flap, consisting of skin, subcutaneous tissue, plantar vessels and flexor tendon. The dorsal skin edge of the stump of the finger was freshened. The end of the extensor tendon was sutured to the distal end of the extensor tendon of the toe and the dorsal skin edge of the finger was sutured to the distal dorsal skin edge of the toe. This necessitated complete immobilization of the parts with the hand in constant juxtaposition with the foot. Plaster-of-paris was not used, it being found complete immobilization could be made by properly placed adhesive and gauze bandages. He was placed in a Gatch bed which permitted flexion of the body to almost an upright sitting position. This gave a fairly comfortable position and relieved tension on the bandages, since at least two weeks is necessary with constant attention and frequent dressings for a union to take place.

The second stage of the operation was performed at the end of that period, as follows. The pedicle flap was cut across transversely, exposing the flexor tendon, which was also cut and sutured to the flexor tendon of the finger. The skin wound was closed with interrupted sutures.

Passive motion confined to flexion, was instituted on the third day after the second stage of operation. Hyperextension was necessary or used. The cosmetic result was satisfactory and sufficient function was obtained to permit the closing of the hand in complete flexion. Sensibility has partially returned. The color of the skin is practically the same as the color of the other fingers.

The value of the operation does not consist alone in giving a more slightly hand, but in restoring the normal length of the finger it gives to those whose occupation requires exceptional use of the fingers an opportunity to continue their work. Professional people, as, for instance, pianists, violinists, typists, and penmen will appreciate a functionally complete member. Laborers, whose chief finger is the thumb, will regain the grasping power that is necessary to continue their wage-earning ability.

Nicoladoni advocates two methods. The first consists in a plastic cuff from the chest into which a graft from the tibia is transferred. This permits of abduction and adduction only, whereas in the second method a transplant of the toe carries with it the extensor and flexor tendons, which offer not only adduction and abduction, but also flexion of the new thumb which restores in great part the grasping ability of the hand. Close application to details is essential. First, to provide a good healthy plantar pedicle flap and the preservation of as many blood-vessels as possible. Secondly, the proper suturing of tendons. Third, strict asepsis and a careful watch to guard against hematomata which are almost certain to become infected and destroy an otherwise perfect result.

If the above precautions are observed, a useful member may be added to the hand at the expense of a seemingly unnecessary toe.

Scar Contracture of Finger—CASE—A man, aged twenty-nine years. When he was eight years old he fell on a hot stove and burned his right hand. The wound healed slowly leaving a marked flexor contracture of the fifth finger. Owing to the skin defect, and as a result of the cicatricial contraction, the finger was drawn to the palm preventing forcible extension. The scar extended to the mid-line of the finger from the second phalanx across the palm to the second proximo flexor crease of the hand. This medium scar was ridge-like and consisted of dense cicatricial tissue which had contracted so that it interfered with his work.

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Operation—The skin was surgically prepared under general anæsthesia. As the first step of the operation all cicatricial tissue was removed. The edges of the wound were freshened and elevated, allowing them to retract away from the field, thus preparing a bed for the transplant. The raw surface left by removing scar tissue was filled in by a single pedicle flap obtained from the back of the same hand and stitched to the edges of the finger. Fourteen days later, the base of the flap was sewed to the proximal portion of the skin wound in the flexor surface of the finger. The wound on the back of the hand was closed. The transplant healed in soundly.

It is very important while a hand is undergoing healing from injury or infection to put the fingers and wrist into functional positions. A hand with a straight wrist with extended proximal finger-joints, and with the thumb at the side of the hand, is practically useless.

The wrist should be placed in dorsal flexion, and the fingers should be partially flexed, especially in their proximal joints, while the thumb should be in slight abduction.

The -Z- incision is valuable in the relaxation of scar contracture of the hand and is used with good results in deepening the commissure in incomplete syndactylism for the relief of a web between the thumb and forefinger.

By interposition of the two flaps made, the scar pull is broken. This method has simplified the handling of many cases which would otherwise have had to undergo a much more extensive and serious operation in order to obtain relief.

Technic—The longest line of the -Z- is laid along the most prominent portion of the web and the arms of the -Z- are marked out on the opposite sides of the central line making a pattern -Z- or reversed -Z- depending on the condition of the surrounding tissues. The arms begin at each end of the central line of opposite sides and are carried outward and downward or outward and upward as the case may be, as far as seems necessary, usually ending at about the level of the middle of the central line. The two flaps thus formed are undercut and mobilized and are transposed, the tip of one flap being sutured into the angle found at the outer end of the arm incision forming the other flap, and *vice versa*.

The flaps should, if possible, be thick and contain subcutaneous tissue to insure good circulation. The irregular wound is then closed with fine silk or horse-hair sutures. Plain gauze dressing is then applied and the part is immobilized.

Webbed Fingers—Webbed fingers or syndactylia may be of traumatic origin, but this condition is usually congenital. When webbed fingers are of traumatic origin the best treatment consists of, first, the removal of all the scar tissue, then cover the defect with a pedicle graft which makes a new web. In the most common form of this deformity the fingers are joined by skin and fibrous tissue up to the interphalangeal joints, but sometimes they are joined throughout the entire length of the finger. It is advisable in infants to separate the completely fused fingers of unequal length to allow unhindered digital growth. Complete separation of fingers, however, and the formation of a new web is not done until the child is six years old.

The best operation for correcting congenital webbed fingers and one that

will not be followed by recurrence of the deformity is performed in this manner. On the dorsal surface of the web make a triangular incision and reflect the flap which should be thick and well nourished. Divide the web uniting the fingers. Turn the flap across the cleft between the divided fingers and suture the apex to the palmar side. If there is a large raw area left caused by the division of the web, it is necessary to Thiersch graft it, if not, the wounds can be simply sutured or brought together with adhesive.

Repair of Tendons in Contractures—Tendons reduced to scar tissues should be excised and replaced by free tendon grafts. Tendons that have been severed for several months must be repaired by tendon grafts, because the distal parts of the tendon will have degenerated from disuse and the muscle will have contracted. Tendon transfers are occasionally useful. It is best not to attempt to replace the original number of tendons but instead, by making some tendons do double duty, to reduce the number of movable parts to a minimum and to furnish sufficient soft mobile tissue between to allow movement. Frequently it is necessary at a later operation to separate the tendons from each other and from the underlying bone by a free graft of paratenon fat taken from over the triceps tendon.

In repairing the tendons of a finger, usually the sublimis tendon is removed so as to leave but one flexor tendon, as two in a finger would adhere to each other. If, though, the sublimis tendon is cut too short at its insertion, the middle joint of the finger is apt to overextend. If cut too long, the stump of insertion will proliferate and fasten itself to the proximal segment of the finger and draw the middle joint into flexion contracture. Wherever a tendon is cut off, unless in a sheath, its unattached or unsatisfied end should be prevented from attaching itself to the surrounding tissues. This can be done by embedding its end in an adjoining tendon or by anchoring it slack, so it will not, by attaching itself under tension, hinder the movement of other tendons which are drawn by a common muscle. Occasionally, after repair of tendons, the mistake is made of splinting the fingers instead of the wrist in flexion. This results in flexion contracture, as the part of each tendon repaired will attach itself to the tissues too far proximal in the limb. Fractured phalanges and metacarpals cause much disability by holding the tendons in callus, thus causing flexion contracture of the fingers. This can usually be relieved by freeing the tendon and placing a graft of triceps paratenon between it and the bone.

It is advisable to wait about one year after the wound has healed before inserting a tendon graft or before performing a tendon transplantation operation.

A sloughing tendon is eventually replaced by a contracting cicatrix which attaches to surrounding tissue and draws the point into flexion. The tendon sheath proliferates greatly, and similarly attaches itself and contracts. Such a firm cord cannot be drawn out by continuous traction. Physiotherapy is useless. The damage found at operation is always worse than expected. If

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the tendon is severed in a sheath, the tendon ends will be found rounded over and without proliferation and free in the sheath. If severed in paratendon, however, the tendon will send out fibres which may be an inch or two long and considerably thicker than the tendon itself.

These fibres will attach themselves firmly to whatever they touch and anchor the tendon end. If the tendon is severed where there is no gross paratendon, but merely a thin slippery layer, as is seen in the palm, even here a thick translucent jelly-like substance will soon extend out as a pseudopodium and attach. Thus, if a tendon end is unsatisfied it will by growth reach out and firmly attach itself. In an end-to-end suture of a small tendon to a large one, care must be taken to enclose the unsatisfied part of the large end or it will reach out by a pseudopodium, and become so attached. This will hold back the common muscle which pulls the tendons of the other fingers and so limit the action of all the tendons. The distal end of a flexor tendon left in a finger will contract and draw the finger into contracture. That part

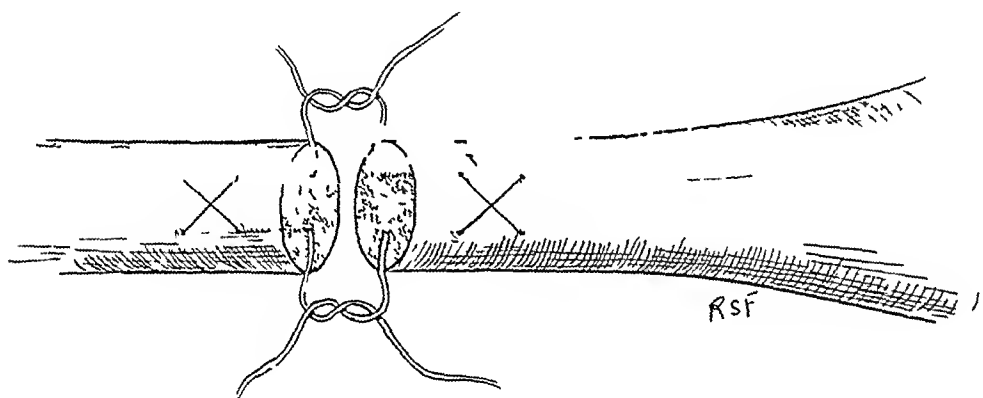


FIG. 8—Author's Tendon Stitch. Showing suture in place, knots only partly tied.

of a flexor tendon distal to an attachment always becomes adherent throughout the length of the finger.

TENDON SUTURE *Technic of Author's Stitch*—The needle enters the tendon on its lateral surface half an inch above the cut end, passes transversely through half the thickness of the tendon to emerge on the opposite side. The needle then enters the tendon on its anterior surface, at a point half an inch from its cut and three-fourths of the distance across the tendon. Perforating to half its anteroposterior thickness, it passes longitudinally through the length of the tendon emerging at its cut end to one side of the median line. The free end of the silk is crossed diagonally over the other suture, perforates the tendon half an inch from the cut and passes through the length of the tendon and emerges on the other side of the median line. Sutures now are passed in similar fashion into the other end of the cut tendon, and then tied to corresponding sutures opposite. Bury the suture knots between the approximated tendon end. (Figs 8 and 9.)

Where the two severed tendon ends cannot be brought together because of muscular contraction, or because they are deeply buried in dense fibrous tissue, I have obtained good functional results by removing the injured segments and inserting a graft of tendon with its sheath. A strip of the tendo achillis may be used. The tendons of the palmaris longus, the flexor sublimis digitorum, and the extensor communis digitorum can be easily dissected with their sheaths and make excellent grafts for tendon defects in the hands and fingers. The tendon sheath is then sutured with fine catgut.

Provided the wound is healed, passive movement can be commenced at the end of three weeks. Voluntary motion should not be begun before the end of six weeks, as it has been demonstrated by animal experimentation that it takes six weeks for a cut tendon to be firmly united. Before that time, newly united tendon will stretch with loss of good functional results. Passive movements should be made with as long excursions as possible, and the best results are obtained if these passive movements are alternated with absolute rest.

Even though passive movement has been started at the end of three weeks, and voluntary motion attempted at the end of six weeks, the development of adhesions is almost inevitable, making necessary the second stage of this operative procedure.

In three of my cases, the tendon had united perfectly, yet adhesions had interfered with function and a good result was obtained only after the following secondary operation was performed.

Technic of Secondary Operation—Make a lateral, longitudinal, curvilinear incision, the longitudinal part of the incision being placed midway between the palmar digital nerve and artery, on a level with the flexor tendons and dorsal artery. The curved part of the incision is directed toward the volar surface. A flap of skin and subcutaneous tissue is raised and retracted to bring into view the sutured tendon, and if bound down by adhesions must

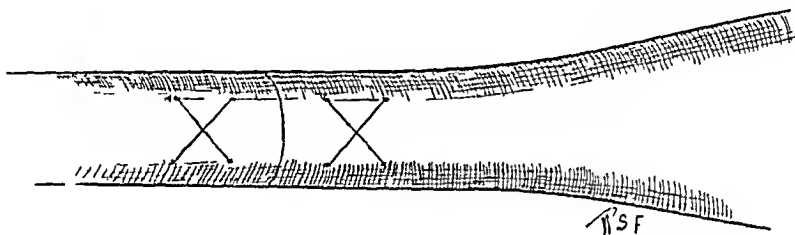


FIG. 9—Showing suture tied the knots buried between cut margins of tendons

be freed to leave the tendon surface smooth. In addition, the sutured segment must be the same size as the rest of the tendon. When the wound has healed, inaugurate gentle, passive movement with long excursions and rest intervened. Note that the stitch described above avoids post-operative separation of the tendon ends, is easy and rapid of accomplishment, and by burying the sutures between accurately approximated tendon ends, a smooth surface is obtained.

Avoid adhesions at a point when a knot on the surface would encourage them.

INJURIES TO THE HAND INVOLVING BONES AND JOINTS—The third group of cases is that in which bone and joint injury has occurred. The bones of the hand and wrist are often fractured or dislocated at the time when traumatism of the skin and subcutaneous tissue takes place. Occasionally, fractures but more usually dislocations of the carpal bones are not diagnosed by the roentgenologist, although anteroposterior and lateral views may have been taken. Stereoscopic views are absolutely essential to accurately diagnose the wrist injuries. Bone injuries are least likely to be overlooked, because the patient usually requests an X-ray examination. X-ray films are frequently invaluable in litigation processes which may follow.

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Arthroplasty for Bony Ankylosis of a Finger-joint—An arthroplasty for bony ankylosis of a finger-joint is performed by resecting one of the two articular surfaces of the affected joint, preferably the head of the proximal phalanx of the finger. The operation is performed through a lateral incision in the space between the dorsal and palmar digital arteries. In some cases, however, the proper exposure requires a second incision on the opposite side of the finger. In the next step of the operation, the new joint cavity is filled with a free transplant of fat obtained from the abdominal wall. The skin is closed with interrupted silk sutures.

Post-operative Treatment—This consists of traction after the operative wound is healed. The traction is followed by active motion, baking and massage.

Recovery of function is slow, and four months usually elapse before the patient is able to fully extend his finger and flex it to the palm.

The difficulty and delay which is encountered in the restoration of the function is due mainly to the proximity of the joint to the skin surface, causing adhesions.

Because of these adhesions formed between the tendons and joint surfaces the period of disability is increased.

This complication should be prevented by physiotherapy measures which have been already enumerated.

Injury to the Joint—When the joint capsule continues to hold the finger in a flexed or in an overextended position, it is necessary to correct this deformity. The correction of the deformity is best accomplished by either capsulotomy or by excising the contracted part of the capsule, which may be on the palmar or dorsal surface, but it is always on the shortest part of the contracted portion of the capsule. Simple incision of the capsule is usually not sufficient, as the wound edges will tend to reunite, thus defeating the purpose of the operation.

In order to secure a satisfactory result, it is advisable to excise a portion of the capsule. By doing this one can secure a joint whose functional ability is at least 70 per cent of the normal mobility. Concerning the wrist, it is known that the grip of the hand is markedly diminished when the latter is in palmar flexion. Therefore when such a condition exists, it is necessary to place the wrist in dorsal flexion. The best functional result is obtained by placing the wrist in 120° dorsal flexion. The most desirable method for securing such a position is to remove the proximal row of carpal bones, and perform an arthroplasty. The latter operation produces a very serviceable wrist. Arthrodesis in dorsal flexion produces very little disability, and will make the flexor muscles available in the forearm.

Stabilization of the wrist in dorsal flexion, whether it be by arthrodesis or through the action of the extensor muscles of the wrist, is absolutely essential for a good grip, as otherwise the flexion of the fingers would draw the wrist also into flexion and so the fingers would lose their strength.

CASE—A woman, aged twenty years, while walking in the street, stumbled over a railroad track, fell to the ground, dislocating the middle phalanx of the right hand. No attempt was made to reduce the dislocation until about nine weeks after the accident, when an operation was performed under general anæsthesia, as it was impossible to reduce the dislocation without an open operation.

A two-inch longitudinal incision was made along the outer border of the fifth finger, and the joint exposed and opened.

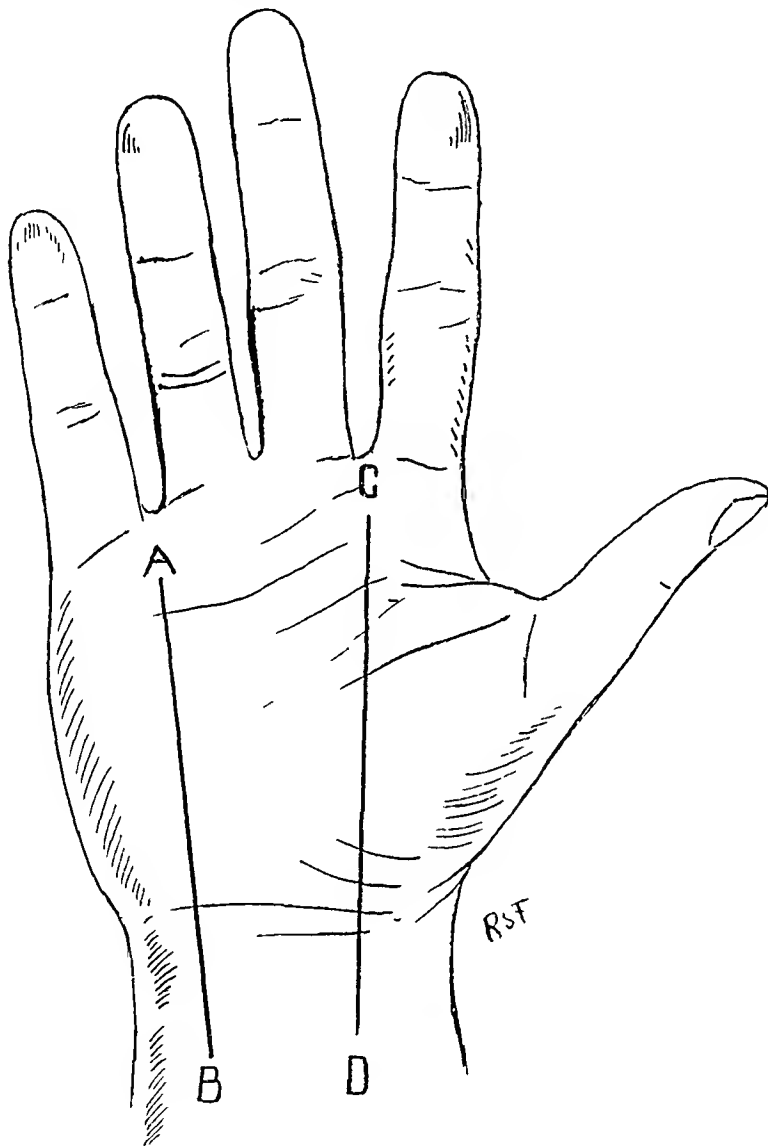


FIG. 10—(A, B) Line of incision to expose the ulnar nerve in the palm
(C, D) Line of incision to expose the median nerve in the palm

It was found necessary to resect the head of the middle phalanx and the capsule was interposed to prevent adhesions in the joint, allowing free motion. The wound was closed and the finger immobilized until the skin wound healed, when passive motion was begun.

INJURY IN OR NEAR THE HAND INVOLVING THE NERVES—These injuries are caused by either direct wounds or by pressure from scars resulting

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from wounds With these patients a great deal can be done and in some instances one can even accomplish a perfect cure in seemingly hopeless cases The direct injuries are usually produced by either a cutting instrument or broken glass the nerves being either cut or torn The indirect nerve injuries are usually the tearing of the nerve by a fractured bone

Treatment consists of three surgical procedures (1) Nerve suture, (2) neuroplastic, (3) orthopædic operations, tendon transplantation, arthrodesis, or both

Injuries in or near the hand involving only the median or ulnar nerves are relatively rare, because cut tendons or muscles are almost always associated with them The nearer a median or ulnar nerve severance is to the hand, the better the prognosis after repair, because nerves in or near the hand are not mixed nerves, hence sensory fibres are not lost in growing down motor tracts and *vice versa* This is especially true of primary nerve suture of the median and ulnar nerves in the region of the wrist (Fig 10) Before suturing these nerves, it is necessary to flex the fingers and hand slightly to bring the nerve ends together The greatest care should then be taken to identify each structure If the median nerve is to be sutured, it is essential to identify the palmaris tendon, and also that of the flexor carpi radialis Little difficulty should be experienced in differentiating between a nerve and a tendon but it is surprising how often one finds the end of the palmaris longus tendon sutured to the end of the median nerve A tendon is flattened, more compact, and a glistening pearly white A nerve is dull, cylindrical, darker, gray, and of softer texture If difficulty is experienced in identifying the upper end of the nerve, it will help to follow up along the edge of the flexor carpi radialis tendon If the lesion is in the lower end it may be necessary to divide the annular ligament and palmar fascia The median nerve may be identified as it passes along the radial side of the superficial flexor tendons In suturing the stump of nerves, the author prefers either fine silk or fine linen as suture material The main objection to chromic gut is the irritation produced by the chromic acid

In suturing a severed nerve it is advisable to take up only the sheath This should be grasped with a fine tooth forceps while the sutures are being introduced A fine cambric needle should be used for the introduction of the sutures Only enough of the sheath to insure an efficient grip should be included in the suture as inversion is very likely to occur if too much is taken In a case under the writer's care only four sutures were necessary for the median, and four for the ulnar nerves to retain all the nerve bundles within the sheath The first two sutures should be introduced at opposite ends of the circumference After tying them, they are left long so that they may be used to steady and rotate the nerve while the remaining sutures are being introduced

While a nerve is regenerating it is necessary to hold the muscles supplied by it in a state of relaxation for about two or three weeks otherwise their function will not return

Combined Median and Ulnar Lesions—The combined median and ulnar nerve injury at the wrist is a common occurrence. There should not be any difficulty in recognizing a case of total paralysis of both nerves as this appearance of the hand is quite characteristic (Fig 11). The wrist is slightly hyperextended, and the hand inclined to the radial side. The thumb is slightly abducted and lies in the plane of the palm, producing the appearance of an "ape" hand. The first phalanges are moderately extended and passive flexion of the last two phalanges occurs. Marked wasting is seen in the thenar and hypothenar eminences and in the dorsal interossei. The branches to the thenar eminence must be carefully preserved. The nerve passes below the superficial palm arch and divides into its digital termination. Suture of the nerve may be accomplished with patience and exactness in dissection. Usually an operation on the median or ulnar nerve in the palm is only a part of the operation, as in freeing a nerve in scar tissue and to repair cut tendons.

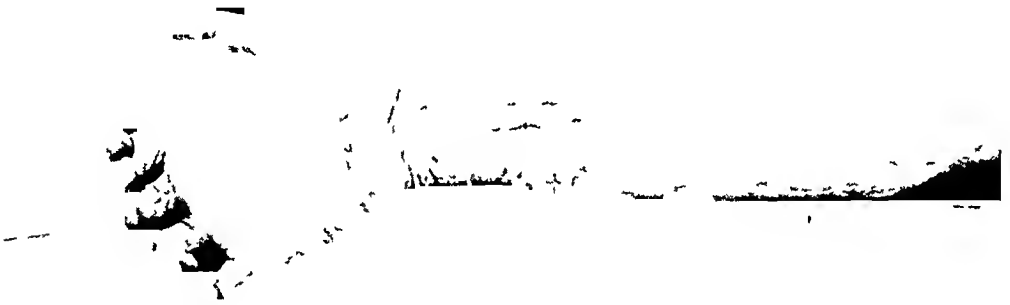


FIG 11—Contractures of palm and fingers from combined median and ulnar nerve trauma. Photograph showing the deformity of the hand about three weeks after the injury. The hand was completely disabled. He could not grasp an object, his only way of holding one was by pressing it between his hand and something else.

To Expose the Ulnar Nerve in the Palm—Exposure of the ulnar nerve in the palm may be obtained by an incision which begins two inches above the wrist and is carried along the tendon of the flexor carpi ulnaris muscle to the radial border of the pisiform bone, and thence distally into the palm in a direction toward the interval between the ring and little fingers. The nerve is first exposed above the wrist by retracting the flexor carpi ulnaris tendon toward the ulnar side of the hand and in the palm by dividing the palmaris brevis muscle.

The deep branch which is given off from the edge of the nerve opposite the lower border of the pisiform bone is traced to where it pierces the septum between the abductor and flexor minimi digiti muscles. By splitting the septum and retracting these two muscles, the nerve may be followed and freed distally.

To Expose the Median Nerve in the Palm—To expose the median nerve in the palm, an incision is made from the insertion of the palmaris longus tendon into the palmar fascia to the web between the index and middle fingers. The palmar fascia must be divided and the flexor tendons identified. Near the wrist, the median nerve lies on the radial side of these tendons.

An incision in the palm for drainage of the thenar space should not extend farther

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than an inch below the wrist, as a deep incision extending closer than an inch to the wrist is apt to sever the median nerve and so rob the thumb of the power of opposition



FIG 12—View of the hand, showing the power of extension subsequent to repair of severed median and ulnar nerves, also all the flexor tendons of the right wrist

Comments—It is extremely important that operative measures for repair be instituted immediately in all injuries of the hand. If postponed too long trophic changes in the joints take place.



FIG 13—Photograph shows the power of flexion subsequent to operation for complete division of the median and ulnar nerves, the flexor tendons and the ulnar artery

A tourniquet properly applied is an invaluable aid to accurate identification of anatomical structures. It is also useful in that it obviates traumatizing dissections and permits a more rapid completion of the operation. If the tourniquet is improperly applied, there is obstruction to the venous return.

without obstruction to the arterial flow and the end result is a bloody field which is worse than no tourniquet at all

Ordinary skin grafts on pressure-bearing surfaces are very prone to slough. The application of the full-thickness pedicle graft is a most reliable and efficient method, because it withstands pressure best, it should be used in grafting these areas.

Denuded skin areas in a large granulating wound should be covered with either Thiersch or Pinch grafts immediately to obviate the danger of subsequent infection and contractures. This shortens the convalescence and curtails the number of painful dressings.

X-ray films in two views as well as stereoscopic pictures should be taken in all wrist injuries.

Patient and prolonged treatment is frequently required in hand injury reconstructions but in this the patient is usually willing to cooperate, because he realizes the continued improvement in his condition. Many of the cases of partial or complete loss of functions of the finger and hand, due to infections or injuries, may be greatly improved or entirely cured by the proper surgical procedures (Figs 12 and 13). From the surgeon's viewpoint surgery of the hand is frequently tedious and requires considerable patience and prolonged after-treatment. The efforts are, however, well repaid as one seldom finds a more grateful patient than the one who has had the use of his hand restored to him after he has despaired of such a possibility.

Special attention is called to the old surgical axiom of immobilizing the hand in the best functional position when ankylosis is anticipated.

CASE—Man aged twenty-eight years was admitted to hospital August 7, 1931, with the history that on the previous day he had thrust his right hand through a glass door and suffered a cut above the wrist by which had been severed the ulnar and the median nerves, the tendons of the flexor ulnaris and the palmaris longus muscles, also all of the flexor tendons of the sublimis and profundus muscles, the hand was motionless in extension. The condition was one of transverse laceration extending through all the anterior soft tissues down to the pronator quadratus muscle. The transverse incision was enlarged and a longitudinal incision at right angle and at mid-line was made and carried up the arm for ten centimetres and to the same extent downward into the palm through the annular ligament. The ulnar artery was ligated, the retracted exposed tendons were matched up and sutured, the nerves likewise. Interrupted fine silk sutures were applied to the nerves, plain catgut used for blood vessel ligation, the fascia and annular ligaments were brought together with silk, a splint was applied to the forearm fixing the hand in extreme flexion. He was readmitted January 13, 1932, for treatment of contracture of wrist and fingers. The scar was excised January 14, adhesions about the wrist were separated freeing the tendons, no drainage, skin closed with interrupted sutures, fingers and wrist held in extension by splint. Following the first operation, sensation began to return on the fourth day, at the end of three months complete return of sensation had developed. Following the second operation, seven months after the injury had been received, complete use of the hand was attained after eight weeks with the aid of extensive physiotherapy.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD MAY 1, 1933

The President, DR JOHN SPEESE, in the Chair,
CALVIN M SMYTH, JR, M D, Recorder

PERISTALSIS AND PERITONITIS

DR HENRY P BROWN, JR, read a paper with the above title

DR I S RAVDIN remarked as to the relationship of intestinal peristalsis to the spread of peritonitis, doubtless only those cases in which the original focus of infection had been removed or repaired were referred to. There has been a tendency, not so much in this country as abroad, to use the so-called cathartic treatment in peritonitis. Doctor Brown believes that the overcoming of the factor of toxic absorption is a definite advantage in the recovery of a good many of his patients. Just what this toxic factor is no one at present knows. As for the infections in the lower abdomen, if the peristalsis is a factor in their spread this must take place in a reverse direction to normal peristaltic activity. Very little is known regarding the relationship of the administration of drugs and their influence on the rate of absorption of substances from the peritoneal cavity. In regard to the use of morphine it is well to remember that in the dog morphine acts entirely different than in the human being in that it stimulates peristalsis.

Good surgery, plus fluid and salt, are essential in the treatment of these cases, an aspect of the problem which deserves more attention than it has received in the past. During the past four months the speaker has used "Pitressin" in cases of this type. Pitressin stimulates peristalsis and in certain instances its use has proven quite beneficial. An ampule may be given every four hours for as many as seventy-two hours after operation.

DR CALVIN M SMYTH, JR, said that about twelve years ago, Dr J E Sweet and he were conducting a series of studies on peritoneal absorption. In their experiments upon dogs the rate and absorption from the peritoneal cavity was determined by injecting various solutions and also particulate bodies in suspension. The particulate bodies used were red blood-cells and lamp black. By collecting the thoracic-duct lymph it was possible to determine the rate of absorption by noting the appearance time in and the time required for disappearance from the thoracic-duct lymph of these bodies. It was noted among other things that anything which increased peristalsis increased the rate and amount of absorption of both fluids and particulate bodies from the peritoneal cavity. The speaker was sufficiently impressed

by his observations at that time to completely satisfy himself regarding the desirability of complete anatomical and physiological rest of the intestine in the presence of intraperitoneal infection. He added that if one accepts the dictum that the source of the toxæmia lies in the peritoneal cavity, anything which tends to increase absorption from this area is harmful to the patient. Naturally, the retention of potentially toxic material within the lumen of the bowel is harmful to the patient also, but it would seem more logical to relieve this situation by a decompression of the bowel through enterostomy or cæcostomy, which entails no stimulation of peristalsis, rather than by forced evacuation of the bowel through increasing peristalsis. May not the fact that the surgeon always waited anxiously for the passage of flatus following the operations under consideration be regarded as the evidence of abatement of the infection rather than assume that the improvement following the return of peristalsis is "*post hoc ergo propter hoc*"?

DR JOHN O BOWER said that a survey of the clinical records of patients operated upon for appendicitis in the hospitals of Philadelphia showed that of those admitted without having taken a laxative one in eighty died, of those who took one laxative, one in thirteen died and those who took more than one, one in seven. Increased peristalsis and increased intestinal pressure increase the possibility of perforation and spreading peritonitis, the cause of death in over 90 per cent of those who died from acute appendicitis.

DR J STEWART RODMAN said that he was very much impressed a year ago while visiting one of the New York clinics to hear the report of a series of cases of peritonitis in which pituitrin had been used. Up to that time he had held the prevailing opinion that it was distinctly not the thing to do, to stir up peristalsis under such circumstances. Since that time he has tried it in about six cases. While he is not armed with accurate statistics as to the amount used in each case, the usual dose was one ampule of surgical pituitrin every four hours for several days or one week if necessary. One of these cases died but might have also had not this been done. The distention was greatly relieved in most of the patients and vomiting checked. Doctor Brown has emphasized the importance of removing the focus of infection and drainage prior to the use of pituitrin, this is important, and the answer, Doctor Rodman believed, to the objection raised to its use by Doctor Bower. While he has just begun its use, therefore, his preliminary impression is that it is a distinct help in the management of these cases.

DR THOMAS J RYAN said that there is grave danger in advising the use of pituitrin in the routine of post-operative treatment. At least until we have means at our command to differentiate between dynamic and adynamic ileus we should desist from anything that is going to stimulate peristalsis. No one has scientifically proven that the patients die from absorption of toxins from the gastro-intestinal tract, but rather, from the bacteria in the peritoneal cavity which are producing the stimulus for the production of ileus.

which in itself is protective. The speaker wished to go on record as being opposed to the routine use of pituitrin post-operatively until its use is based upon scientific information rather than clinical impressions.

DR F. A. BOTHE said that he had used "Pitressin" in cases of distention recently and had some very good results. In some instances great quantities of gas were expelled. In addition to extracts of the pituitary gland, certain drugs have been used to stimulate peristalsis. The intravenous use of 20 per cent sodium chloride appears to have been the most satisfactory. Experimentally, the peristalsis has increased more in the obstructed animal than in one in which there was no obstruction present. This finding has raised the question as to whether osmosis plays any part in the increased peristaltic activity.

DR BENJAMIN LIPSHUTZ said that about two years ago Doctor Fleming reported a number of cases of peritonitis from perforated ulcers and he showed clearly that those patients who received pituitrin and those who had enemas always exhibited elevation of temperature and that particular group had a much higher mortality than the group treated without any peristaltic aggravation.

DR EDWARD T. CROSSAN said that in spite of the successful results reported by Doctor Brown and the favorable experiences noted by Doctor Ravdin, there is a distinct danger in this form of treatment. He had in mind the possibility of kinks which could be caused by the use of pituitrin or allied drugs when used in cases of peritonitis. In peritonitis the intestines are glued together by a plastic lymph exudate and it is this exudate that acts as anchors to cause kinks. It is a well-known fact that such kinks do occur in convalescent cases of peritonitis at which time the patients show signs of intestinal obstruction, this obstruction is usually relieved by morphine and abstention of everything from mouth. If this complication occurs when peristaltic stimulants are used, it will be difficult to prove that the drug is blameless.

DR HENRY P. BROWN, JR., in closing the discussion, emphasized the fact that he did not advocate the routine post-operative use of pituitrin, but believed that it should be used only when indicated—usually in those cases showing a toxic ileus after the removal of the focus of infection, when such ileus does not respond to the usual post-operative measures. All agree with the statement that in pre-operative cases of acute appendicitis, laxatives tend to cause perforation. The paper did not deal with this subject. He fully agreed that the routine post-operative use of pituitrin is undesirable and he does not recommend its use in this manner. It would be interesting to know what degree of intestinal paralysis and distention was present in those cases which did not receive a peristaltic stimulant and whether or not their condition improved when such distention and paralysis were relieved. He agreed that there are factors which stimulate vomiting in peritonitis and believed

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that intestinal paralysis with its sequelæ plays an important part. The convalescent cases he mentioned which presented signs of obstruction, relieved by withholding fluids, bore out the first statement of this paper, namely, that in paralysis of the intestines, one withholds nourishment by mouth because the intestinal tract is unable to handle such nourishment in a normal manner. If it is not a toxic substance (in the broad use of this term) which kills patients suffering from peritonitis aside from such complications as those of the respiratory, cardiac and renal systems, *etc.*, what does cause the fatal outcome?

THE CAROTID SINUS AS AN ETIOLOGICAL FACTOR IN SUDDEN ANÆSTHETIC DEATHS

DR T. MCKEAN DOWNS read a paper with the above title

REPAIR OF LARGE INCISIONAL HERNIA BY FLAPS OF ANTERIOR SHEATH OF RECTUS

DR NORMAN ROTHSCHILD read a paper with the above title

DR CALVIN M. SMYTH, JR., said that the operation described by Doctor Rothschild appears to be based on sound principles. It has certain features in common with the operations described by Gibson, of New York, and Dixon, of The Mayo Clinic. In these operations, after exposure of the sac an incision is made in the anterior fascia about 0.5 centimetres from its margin and extending throughout its circumference. This leaves a narrow strip or margin of fascia, the edges of which are approximated by a continuous suture of No. 1 chromic catgut. In order to prevent small bits of fat from working between the fascial layers and preventing solid healing, a single running suture is placed near the approximation of the two layers. The edge of the fascia which has been overlapped is then tacked to the underlying portion with another running suture of chromic catgut. The advantage of this procedure is that the peritoneal cavity is not opened and no attempt made to free extensive adhesions, thus rendering the operation much less shocking and decreasing the chance of ileus and peritonitis which are relatively common complications following repair of large incisional hernia by other techniques.

In Doctor Rothschild's operation the feature which would appear somewhat risky is the permanent denudation of the rectus and it will be interesting to learn whether, as Doctor Rothschild hopes, there is a regeneration of the anterior fascia or whether this will prove an obstacle in the obtaining of permanent cures. Sufficient time has hardly elapsed to justify positive statements regarding this point.

TRAUMATIC ANEURISM OF THE SUBCLAVIAN ARTERY

DRS WALTER ESTELL LEE, CHARLES F. MITCHELL, and, by invitation, DR ARTHUR B. PEACOCK, read a paper with the above title

DR WALTER ESTELL LEE remarked that he approached this operation with a certain amount of respect for the surgical difficulties to be met, for one year

CARDIOLYSIS IN ADHESIVE PERICARDITIS

before he had assisted with another case with an aneurism in practically the same position. After exposing the tumor and while exploring with his forefinger, the operator unfortunately tore into the subclavian vein at its junction with the internal jugular. He had excised only the outer two-thirds of the clavicle, which gave inadequate exposure of the bleeding point, and it was necessary to complete the resection of the sternal end of the clavicle and disarticulate it at the sternoclavicular joint, while the hæmorrhage from the subclavian vein was controlled with the assistant's forefinger. This wide exposure made it possible to control the bleeding and finally close the wound in the subclavian vein with a lateral suture. The patient died several hours post-operatively.

In Doctor Lee's case, in order to provide ample exposure, the clavicle was excised subperiosteally except for its outer inch and one-half, and a flap was reflected outward which made it possible to approach the subclavian vessels from the axilla until the scar tissue surrounding the subclavian vessels was reached. The sac of the aneurism was completely isolated before the dissection was started at the junction of the jugular and subclavian veins, and to do this it was necessary to dissect it from the sheath of the brachial plexus and the anterior sheath of the scalenus anticus muscle. To expose the second portion of the subclavian vessels it was finally necessary to cut the tendon of this muscle. At this point it was very difficult to decide about the point of communication between the aneurism and the vessels, but this decision was made for them, as the neck of the sac tore. Doctor Brown, by pressing the first portion of the subclavian artery against the first rib, was able to control the bleeding and make it possible to close the opening in the wall of the subclavian artery by mattress sutures of silk. At the completion of the operation the radial pulse was present and has never disappeared. This seems to be evidence that at no time did they completely obliterate the lumen of the subclavian artery. There was some loss of sensation and tingling at the distribution of the brachial plexus but this had entirely disappeared when he was examined one week ago.

THE OPERATION OF CARDIOLYSIS IN ADHESIVE PERICARDITIS WITH PICK'S SYNDROME

DR. WALTER ESTELL LEE, and, by invitation, DR. FLOYD O'HARA, read a paper with the above title for which see p. 152.

DOCTOR LEE had been able to find records of some ninety cases of cardiomyolysis in the literature. This includes not only the true Delorme type of cardiomyolysis, but also the decompression operation of Brauer. His first case convinced him that there is a real danger in these operations of relighting latent infection. This patient had pneumonia, empyema and pericarditis some eight years before the operation and the wound infection which was developed on the tenth day first showed pneumococci and later streptococci. The first case also demonstrated the real danger of opening the pleural cavity in the Delorme procedure. In working with cadavers and in the

post-mortem room he found it the rule rather than the exception for the right and left pleura to meet in the mid-line as low down as the sixth costal cartilage. This was true in both of these cases. It was because of this difficulty that the exposure of Laney and Shipley was modified by making drill holes in the sternum and the sternoclavicular joint approached from the medial aspect. As one might expect, the real difficulty in the operation is the removal of the bony cage overlying the pericardium without opening the pleura and subsequently the separation of the pleura from the pericardium without injury. The removal of the pericardium itself is the simplest part of the procedure.

DR GEORGE GRIFFITH said that he first made the diagnosis purely on the basis of finding the five criteria which Cohnheim laid down when the condition was originally described. He found no definite etiology, a very rapid heart, a very low blood-pressure, small heart, no matter in what position he was turned, and in addition a very high venous pressure. The electrocardiograph disclosed typical inversion. The cardiac output at the hospital proved this diagnosis. It was forty cubic centimetres when it should be seventy to eighty. A heart not too badly damaged, even though in auricular fibrillation should be operated upon. Two cases which the speaker saw operated upon in Boston were much more ill than this boy. His heart rate was regular and he had no signs of decompensation other than the fluid in the abdomen and lung and there was very little œdema of the ankles, so that even badly damaged hearts may be operated upon if it can be done under local anæsthesia, intratracheal, or with open drop ether.

BRIEF COMMUNICATIONS

EXSTROPHY OF URINARY BLADDER

IMPLANTATION OF BOTH URETERS INTO RECTUM

PROLONGATION OF LIFE TWENTY-FOUR YEARS

A BOY three and a half years old was admitted into St Luke's Hospital of Bethlehem, Pa., in the summer of 1908, on account of a marked lack of development of the lower anterior walls of the abdomen

Not only did he have exstrophy of the bladder but the two sides of the abdomen from below the pubis almost to the umbilicus had failed to develop so that there was an oval interval of about six by eight centimetres. The interval was filled in by the posterior wall of the bladder, and bordered by an irregular raised edge of skin. The pubic bones not only had failed to unite but there was an interval of one centimetre between the bones where the symphysis should have been. There was also complete epispadias.

By a series of plastic operations we constructed and brought together the anterior walls of the abdomen and made a fair-sized pouch to act as bladder, with a short tunnel to serve as urethra. The pubic bones were pressed together and held together by silver wire bands or sutures. No attempt was made to construct a penile urethra.

This construction surgery resulted in a reservoir for urine and a short urethra or canal of exit. This enabled the boy to restrain the constant dribbling of urine. As there was no sphincter to the canal it naturally followed that when the pouch was full it ran over and discharged involuntarily.

The case was discharged in the early Fall with careful instruction in regard to scrupulous cleanliness and frequent irrigation of the new bladder.

The child was brought again to the hospital January 20, 1909. He was in a most pitiable and foul condition. Calcareous deposits were found lining the artificial bladder and urethra, the skin about the exit canal was eroded and inflamed, and serious sepsis had begun. It required nearly six months to get the case in a clean and fairly healthy condition again. His parents were too ignorant and negligent to be entrusted with the care of the child with such a makeshift bladder and urethra. It was therefore determined to excise the bladder and implant the ureters into the rectum.

June 16, 1909, the whole operative procedure was done at one time. The ureters were carefully detached from the bladder by encircling their entrance orifices by an incision about three millimetres around from these orifices. Thus a cuff of mucous membrane of three millimetres was carried into the rectum around the exit orifice of the ureters and sutured to the mucous membrane of the rectum bordering the small incision into the gut. Then the rectal walls were closed by sutures which held the ureters in place in a slightly oblique direction. No sepsis followed the operation. The urine was well retained in the rectum and after twelve hours the flow seemed free and adequate. The wounds all healed rapidly and the convalescence was uninterrupted.

The child was kept for observation in the hospital for forty days after the operation. When it was sure that his kidneys functioned well and there was no ascending infection and that his rectum was tolerant the case was discharged.

About his fourteenth year I saw the boy again. He was in good health. His urine was discharged through the anus something like every six hours during the day. He was not disturbed during the night. He was a bow-legged chap. The pubic bones were in good juxtaposition but not united and moved a little at their junction when the boy strode along. This caused some waddling in his gait. He was active and muscular,

though he was small for his age. His parents refused any operation to remedy the epispadias.

Ten years later I saw and examined him again. His bow legs and waddling gait were still present. He discharged urine by the anus three or four times a day and was able to sleep through the night without any necessity to evacuate urine. He was small but was muscular and a hardy-looking man. He said he felt strong and well in every way. He was a motor-truck driver and worked long hours.

The physical examination showed no lesion of the chest, the abdomen was firmly closed, the pubic bones were close together but not united. He was quick and very active. The epispadias was still present and he and his father again refused to have any operation done for its closure. His testicles were rather small, well formed and seemed normal.

February 2 of this year, 1933, he was brought to the hospital. His lower extremities were useless and he complained of severe pain in both legs. No interruption of sensation, the reflexes were all good, as well as the tactile sense. Soon he began to vomit. He recovered the use of his lower limbs. In a few days he was in a coma and died on the first of March.

He was twenty-seven years of age when he died. He lived in health and activity twenty-four years after the ureters were implanted into the rectum and gave a history of having been quite well until a short time, two weeks, before he was admitted to the hospital. He died of uræmia. The report of the autopsy by the pathologist of the Hospital, Doctor Rothrock, is particularly interesting and important. At no time was there any indication of an infection of the pelvis or medulla of the kidneys but he died of glomerular nephritis.

Autopsy Report—The body is that of a young white male. The legs are very short and markedly bowed. The penis is rudimentary with an epispadias. There is a sinus just above the base of the penis that connects with the rudiments of the bladder. The skin of the body is pasty in appearance and there is an icteroid tint to the color of the skin.

Lungs—Gross examination shows both lungs to be normal in relation to the chest cavity. There is no excess of fluid in the chest cavity. There is an occasional old adhesion between the parietal and visceral pleurae. Both lungs show a chronic passive congestion being more pronounced at the dependent portions. There are no areas of true consolidation. There are no emboli or thrombi found in the vessels.

Heart—There are no adhesions between the visceral and parietal pericardium. The musculature of the heart is quite flabby. There are no diseased processes found on the heart valves. There is an atheromatous change of the ascending aorta resulting in numerous raised yellow plaques that are not calcified.

Liver—The liver is somewhat paler than is normal. The cut section shows the venous channels to be congested with blood. There are no masses found in the liver.

Spleen—The spleen is normal in size. The cut surface shows an increase in the blood content. There are no infarcts found.

Pancreas—No gross abnormalities are seen.

Stomach and Intestines—No abnormalities seen other than those to be noted later with the rectum. The common and cystic ducts from the gall-bladder are patent.

Adrenals—No abnormalities seen.

Bladder—The bladder is rudimentary and connected with a sinus to the skin. The wall is thickened and in the area of the bladder are small, rather thick-walled cysts that are most probably rudiments of the bladder left from the original operation of constructed bladder and urethral remnant.

Kidneys and Rectum—The kidneys are both very granular with many contractile scars on the surface. The capsules strip easily. The left kidney is very small, measuring about five centimetres in length, however, it has the same general appearance as does the larger kidney. Both kidneys contain a cloudy urine in the pelvis but this does

EXSTROPHY OF BLADDER

not appear to be under pressure The pelvic wall of both organs is thickened The ureters of both kidneys have been transplanted into the anterior aspect of the rectum at about six to eight centimetres from the anal opening The ureters are both greatly thickened, measuring in places about one centimetre in diameter Both ureters are patent The opening of the ureters into the rectum is surrounded by apparently normal mucosa

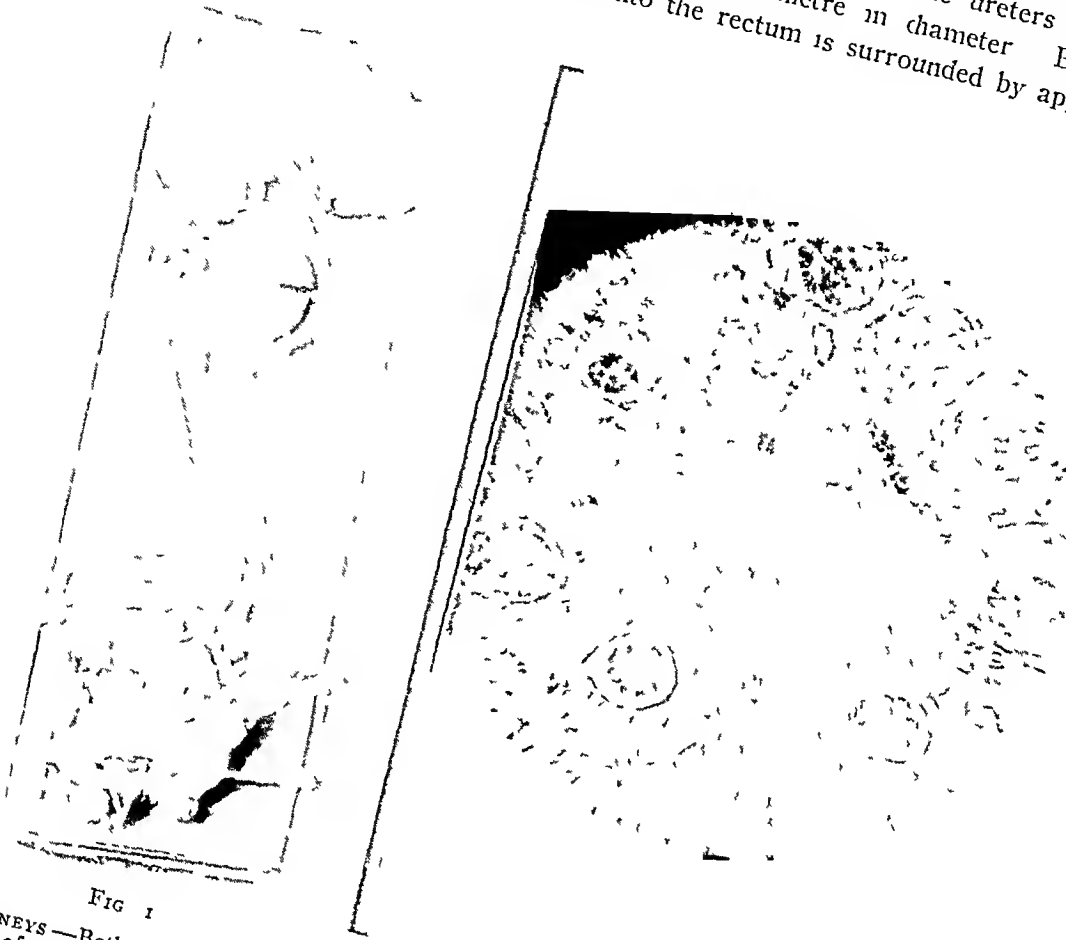


FIG 1

FIG 2

KIDNEYS—Both kidneys show the same general appearance though the left kidney is about half the size of the right The surfaces of both organs are very granular with many depressed scars The capsules strip with difficulty, tearing the underlying surface The cut surface shows both the cortex and medulla to be thinner than is normal, with the greatest loss of thickness in the cortex Both organs are pale The pelves of both contain a cloudy urine

FIG 1—Kidneys and rectum (opened on posterior surface) The thickness of the ureters is well shown The two probes are in the rectal openings of the ureters

FIG 2—Low power photomicrograph of the right kidney showing the marked interstitial inflammatory reaction characterized by a small round cell infiltration and increase of connective tissue

Microscopical Examination of the Kidneys—Microscopical examination shows a marked change of both the parenchyma and the supportive tissue The glomerular capsules are thickened with multiple layers of flattened spindle cells Some of the glomeruli are congested with blood while others are blood Some of the glomeruli are replaced with hyaline masses The convoluted tubules show a marked degree of cellular degeneration with fragmentation and lack of staining by the nuclei Many of the tubules are filled with granular material and hyaline material Some of the tubular epithelium shows a fatty change There are areas of tubules that appear to be attempting regeneration, the nuclei being hyperchromatic and the cells markedly cuboidal in appearance The interstitial tissue shows many areas of small round-cell infiltration with destruction and replacement of the infiltrated tissue These cells appear for the most

part to be lymphocytes and plasma cells. In some areas this infiltration is definitely perivascular. The smaller arteries and arterioles show a hyperplasia of the muscularis.

Diagnosis—Chronic interstitial nephritis with secondary contraction and parenchymatous degeneration.

WILLIAM L. ESTES, M.D.
Bethlehem, Pa.

SCALENIOTOMY AS AN ADJUNCT TO PHRENICECTOMY

THE scaleni by their insertion into the upper ribs probably form the base or level for the action of the intercostal muscles. The two, or usually three, scaleni arise from the anterior tubercles of the transverse processes of the third, fourth, fifth and sixth cervical vertebræ. The anticus descends vertically and is inserted by a narrow, flat tendon into the scalene tubercle on the inner border of the first rib and the ridge on the upper surface in front of the subclavian groove. This groove is an excellent landmark in dissecting either of the muscles or the phrenic nerve.

The scalenus medius is larger and longer and arises from the lower six cervical vertebræ. It descends alongside the vertebral column and is inserted by a broad multiform attachment into the upper surface of the first rib, between the scalene tubercle and the subclavian groove and occasionally sends an insertion-band to the second rib.

The scalenus posticus is the smallest and most deeply seated, arising from two or three separate tendons from the posterior tubercle of the transverse processes of the lower two or three cervical vertebræ and is inserted by a thin tendon into the outer surface of the second rib, behind the tendon of the serratus anterior. Occasionally it is blended with the medius. The two diagrams (Nos. I and II) show the initial incision procedure in the two cases reported here. The scar resulting is as good, if not better, than the usual one after phrenicectomy, and one obtains a better view of the structures. In one case, we used the curved incision, in the other the slightly convergent one, not quite parallel to the clavicle. Both operations were done under local anæsthesia, with a 1 per cent. novocaine solution, preceded by $\frac{1}{8}$ morphine. The patient lies on the back, the head turned as far as comfortable to the opposite side. The area is painted with iodine and washed with alcohol. Great care is necessary to guard the subclavian artery and its thyroscapular branch to the left of the anticus, and the brachial plexus when reaching the medius and posticus. The anticus is best identified by the scalene tubercle and the subclavian groove, making an incision, parallel to its fibres, about two cubic centimetres long into the sheath only, near the tendon, we excised a section of one and one-half cubic centimetres all around the muscle leaving the sheath intact. This prevents the restoration of the muscles after the cicatrix forms. We did the same with the medius and posticus.

The results are best shown by the following reports of the two cases.

CASE I—In October, 1928, an incomplete pneumothorax was made for Mr. H. L., thirty-six years old, with two cavities in the right apex. After nine months' pneumo-

THYROID ISTHMUS CLAMP

thorax treatment these cavities were still visible under X-ray. Expectoration had diminished, bacilli were still present, also slight elevation of temperature *p.m.* In July, 1929, we did an exaeresis. This closed the lower cavity completely. Still there remained a slight temperature, bacilli still present, the sputum diminished to one-half ounce per twenty-four hours. The left apex showed very minimal infiltration. In 1931, in February, we opened the phrenic incision, slightly altering the original incision, and dissected the *scaleni*, removing one and one-half cubic centimetres of each muscle near the tendon. We sutured without drain and the wound healed *per primam* within one week. The sputum stopped practically on the fourth day, the cavities were no longer visible, bacilli absent in November, 1931, none present in November, 1932. There is no cough at present, the left apex is quiet, the X-ray shows a practically normal picture, except a smaller thorax on right side, probably due to sinking of ribs.



DIAGRAM No. I

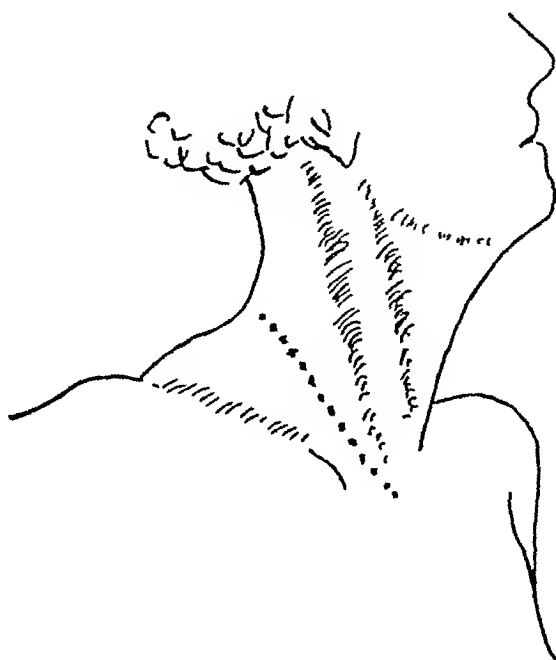


DIAGRAM No. II

CASE II—The second patient, Mrs. M. M., twenty-nine years old, had a pneumothorax of right side at Saranac Lake in March, 1931. She came home in October of that year where an exaeresis was done in March, 1932, at the Polyclinic, N. Y. There was decided improvement for three months, then slowly she began to lose weight and had a temperature of 100° *p.m.* The cavity in the right apex closed, but reopened. At first we thought exercise might have caused this. The patient used an auto almost daily, but since the first patient had rest and yet developed similar signs we decided to excise part of the *scaleni* muscles. We did this in July, 1932. In October, 1932, the cavities were closed and are so today, March, 1933. She regained her weight and added five pounds to it. The temperature is normal, sputum absent. No deformity resulted, excepting a slightly larger depression above and below the clavicle than on the other side.

WILLIAM MEYER, M.D.
New York, N. Y.

ISTHMUS CLAMP FOR USE IN THYROIDECTOMY

IN THE performance of thyroidectomy most surgeons divide the isthmus before proceeding with the resection of the lobes. As a rule a Carmalt clamp is used in order to lift up the isthmus from the trachea and thus protect the trachea against injury during the division of the isthmus.

BRIEF COMMUNICATIONS

The curve of the Carmalt clamp enters the proper line of cleavage without any difficulty. However in guiding the clamp through to the upper border of the isthmus for the division of the supra-isthmus ligament the chest wall is in the way, especially in a patient with a short neck or a broad isthmus. The Carmalt clamp causes unnecessary pulling on the trachea and sometimes difficulty in breathing.

I have overcome this difficulty by combining the advantages of the Carmalt principle with those of a bayonet clamp (Fig 1). This clamp is

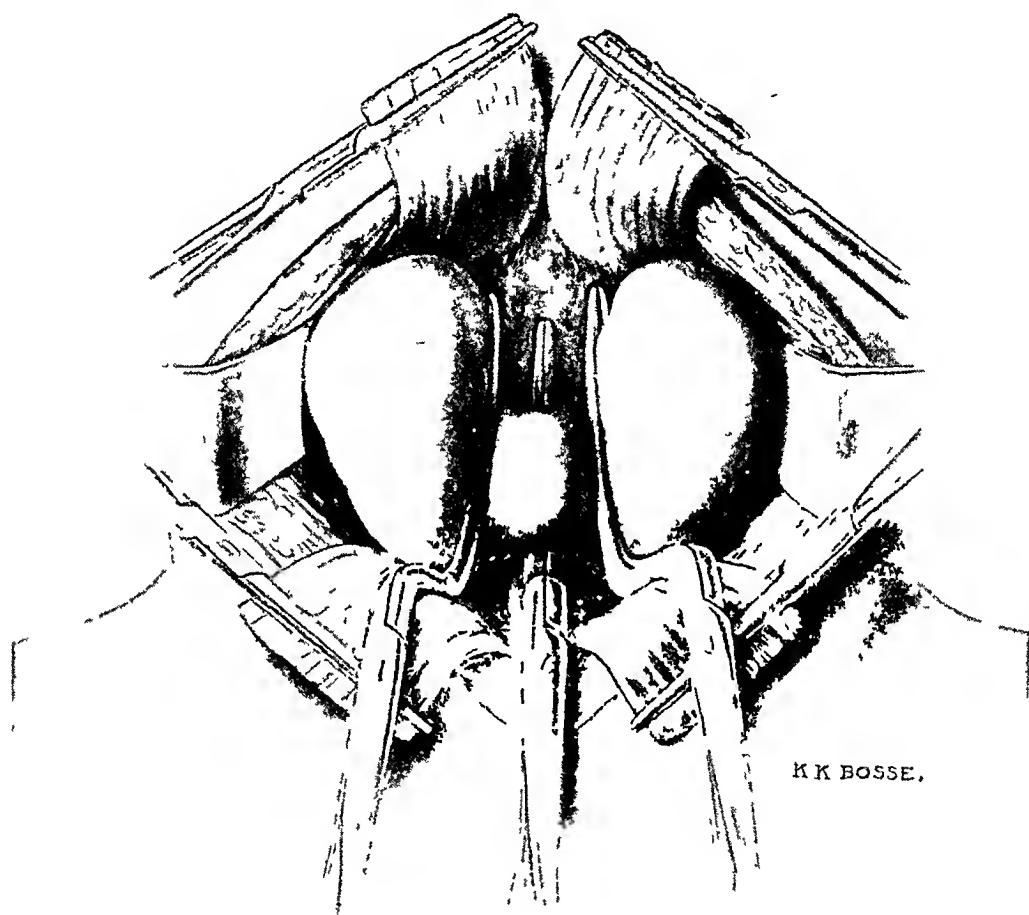


FIG 1—Clamp for the division of the isthmus in thyroidectomy

better adapted to the normal anatomical relations. The introduction of this modified clamp can be accomplished without the interference which the chest wall often causes.

Furthermore the actual division of the isthmus is facilitated, as the curve of the clamps in lateral positions keeps the handles at least two inches apart. The instrument has been constructed by George Tiemann and Company, New York.

RICHARD LEWISOHN, M D

New York, N Y

From the Surgical Service of Mount Sinai Hospital

BOOK REVIEWS

GRAPHIC ART IN SURGERY Surgical art was once the peculiar possession of the individual. In time he communicated something of his skill to others by speech and demonstration. Then the surgeon learned to read and write, and surgical knowledge was transmitted by the printed word. The first pictures bearing on surgery were anatomical. The next were the pictures of instruments. Splints and their application followed. Illustrations showing wounds and the operative procedures are a late development. These were first in the form of cuts. They illustrated two dimensions. It remained for the half-tone artists in the latter part of the nineteenth century to add depth—a third dimension.

But surgical pictures still lack an essential element that may be called the fourth dimension. This is the thing that is needed to make a wound look real. The surgeon engaged in an operative procedure upon a living patient, looks upon a scene but little reminiscent of any picture in a book. Flowing blood, moving tissues, and structures, obscured and again coming into view, characterize the scene. The fourth dimension is the combination of time and space.

The camera has attempted to capture this quality in surgery and make it graphic. But the camera, except for the moving picture, has failed. The photograph of a wound in process of operation is messy and quite unlike what the surgeon sees. Still, art is able to show this fourth dimension. There are pictures of flowing streams, swirling pools, scurrying clouds, sailing ships, and birds on the wing that depict motion and action, and that means the lapse of time. These show the fourth dimension, thus far absent from text-books on surgery. An approach to this ideal is discovered in the pictures in the "Operative Surgery"* now before us. These two volumes with over a thousand pictures, many of which are colored, are the best example of graphic art that surgery has yet produced. While these pictures, on the whole, may be designated as schematic, the surgeon, with his knowledge of wound behavior, easily reads into them the missing fourth dimension.

Surgery is made graphic in this work also by the descriptions of operations in the text. Here, surgery is literally taught. Beginning with the examination of the patient and his preparation for operation, the steps the surgeon must take to attain the best ends of surgery are carried through the operation and the after-care. The resources of surgery are called upon to show how a bad risk may often be made good. The author does not compromise with that practice in surgery which, with an eye to statistical results, denies the bad risk the chance that surgery might offer. As one studies these books he becomes aware that the author not only thinks in surgical but in

* "Operative Surgery," by Martin Kirschner. Authorized translation by I. S. Ravdin, Philadelphia and London. J. B. Lippincott Company (2 vols.)

physiological terms, that he gives consideration to the alterations of function caused both by the disease and by the operation, and that in his procedures he addresses himself to the problem of restoration of function as the supreme purpose of surgery. It is a happy discovery in a work on operative surgery to find that, while the most impressive acts in the art of healing are contemplated, never is it implied that mechanical interference alone suffices.

Here is illustrated a fundamental of surgery: in this art, the doctor himself is the important part of the treatment. He does not prescribe that something be given to the patient and then go his way. He gives himself. The surgeon himself is the medicine.

The author calls attention to the fact that the ease and the lack of danger with which many operations can be undertaken lead too often to surgical interference when neither necessity for the operation exists nor benefit to the patient can be expected. The question, he insists, is not *can* an operation be done but *must* an operation be done.

The operator and his assistants are discussed not only from the standpoint of technic but also from the standpoint of character and personality. The surgeon who assumes the responsibility must be the autocrat in the operating room. The notion of democracy and parliamentarianism have no place in surgery.

We have thought of the internists as especially concerned for the functional efficiency of the heart. In the surgical patient, Kirschner places this responsibility upon the operating surgeon. The capacity of the heart for work is an index of vital resistance which the surgeon should study and the knowledge of which he should control in each case.

The injection and blocking of the trigeminal nerve, as presented in this work, is a fine example of the application to surgery of the principles of anatomy, the pathology of sensation, therapeutics, anæsthesia, and the perfection of this pictorial art. So graphically is this subject presented that there is danger of the ease of attacks upon this nerve being exaggerated in the mind of the reader. It is conceivable that harm may be done to innocent sufferers by the encouragement of the inexperienced to make attempts for which they are not qualified. This observation applies to much throughout this work. The question arises: is it possible for a book on surgical treatment to make the steps of a procedure too clear? The answer must be in the negative. If harm might come from such graphic pictures and descriptions as are here presented, then perfect and geometrically correct delineations lack something surgical. And that is precisely the case. These pictures, as pictures, are perfect, but only the imagination of the experienced surgeon can add the surgical quality necessary to make them complete. Not less perfection but more perfection in surgical pictures is the answer. The unlighted depths, the obscured vision, the nerve that may be seen but not felt, the lowering blood pressure, the living, moving human being—these are things the best pictures fail to show. These constitute a fifth dimension absent from the best of art.

BOOK REVIEWS

The operating room, its architecture, and its organization are made graphic in this work. No detail is omitted. The combination of several operating rooms in relation to a single sterilizing room is worked out in the interest of economy and efficiency. The lighting is given the consideration it deserves. The positions of tables, assistants, and nurses receive meticulous attention. The dressing of wounds, the management of infected fields, drainage, position in bed, and the comfort of the patient are described not in conformity with conventional usages of surgery, but out of the ripe experience of a surgeon zealous for the perfection of his art. This work has an individual behind it, and in it, and that individual is Kirschner.

The method of reintroducing into the veins the extravasated blood, found free in the abdomen or other sterile cavity, is among the practical expedients of the operating room. The quick and simple agglutination tests which the surgeon himself may make are described. The suturing of wounds, the repair of defects by pedunculated flaps, and operations upon special structures are described with surgical feeling. Bone and joint surgery is richly illustrated. Amputations, from the beginning of surgery a confession of defeat, are made at least interesting if not alluring. The kineplastic amputations invite the ingenuity of the surgeon to its challenging problems.

It is only the experienced surgeon who would say that, "a patient whose abdominal wall has once been the site of an incision is left in most instances with a damage that is permanent, even though it may be slight." As a routine, Kirschner uses the Trendelenburg position in all abdominal operations below the umbilicus. To this he adds rotation of the body to expose the viscera lying to one or the other side of the middle. Closing the abdomen, he does not sew the peritoneum separately but with the same suture that includes the transversalis fascia and the deeper muscular layer.

Operations on the intestines are clearly and briefly described and beautifully illustrated. Clamps are dispensed with when the bowels are not unduly distended, upon the ground that clamps always inflict a certain amount of damage to the intestinal wall. The descriptions of operations on the stomach make clear the complicated anatomy of that viscus. The pictures can be read like the text, and the diagrams simplify both. The indications for resection of the stomach are explicit. When the surgeon has explored the stomach for lesion and found none that can be identified through its walls, he is then cautioned to examine the other organs that might have produced the symptoms, and, finding no lesion justifying operation, he should be satisfied to close the abdomen without yielding to the temptation to do something that is not called for. Like all good surgical teaching this book is rich in the ethics of the art.

Gastroptosis is usually the result of some other lesion. It is a disease rarely benefited by operation. Operation is justified only in extremely rare cases. Appendicitis and Meckel's Diverticulitis are considered and treated as similar lesions. Operative procedures in all diseases of the rectum are freely discussed and copiously illustrated. Operations for the treatment

BOOK REVIEWS

of diseases and injuries of the liver, gall-bladder, spleen, pancreas, and other abdominal organs are described with fulness and to the satisfaction of the most penetrating inquiry

These two volumes go a long way toward making graphic the descriptions of surgical operations. They reveal also the experienced surgeon in the fine capacity of teacher of his art

J P W

THE JOY OF LIVING An Autobiography By DR FRANKLIN H MARTIN
2 vols, large 8vo Cloth Doubleday, Doran & Co, Garden City, New York

The two volumes in which Doctor Martin chronicles the experiences of an eventful life cannot fail to command attention. They begin with the account of a young couple who, after trekking westward from Canada through New York, Pennsylvania, Ohio, Indiana and Illinois, found a home at last among the lakes of Wisconsin. Here, in 1857, the boy Franklin was born. About him were all the conditions of Western pioneer life. The record of what entered into that life from the time of his birth to the present time constitutes these volumes. The book intrigues one's interest from the start. One finds it difficult to lay it down when once it has been taken up. The ability of the author by his vivid word-painting to awaken an interest even in apparently insignificant and irrelevant occurrences is most interesting and engaging.

An especial value must attach to the account of medical education in Chicago at the time that the young man, alternating between the school teacher's rostrum and the brick yard, makes up his mind that he will become a physician. The difficulties that he overcomes, his dogged persistence in the pursuit of his end, constitute a tale significant of the character of the man and prophetic of future accomplishments.

The professional life of Doctor Martin presents three special achievements: the establishment of an authoritative association which has elevated the standards of surgical education and increased the attainments of its possessors, the establishment of an important and influential surgical journal, the mobilization of the medical profession of the United States in answer to the call of a great war.

The very intimate relation of the various steps by which these ends were achieved as narrated by the author commands the constant attention and great interest of the reader.

Of the many things which this story embraces the one which appealed most to the heart of the reviewer is that of the farewell of the author's father, a soldier recruit for the army of the Union, as he takes leave of his family for the front never to return.

Of the many characters which in a kaleidoscopic manner flit across the pages of these volumes there are two which display in an especial manner the pictorial art of the writer. The one is that of his associate on the advisory Commission to the Council of National Defense, the sturdy Samuel Gompers, head of the American Federation of Labor, as he continually watched over

BOOK REVIEWS

the interests of those whom he called "his boys" while he steadily smoked up his twenty-five daily cigars, and with him is associated the peerless Gorgas, the courteous, imperturbable, capable, victorious sanitarian

Through the events of the World War we follow the author and rejoice with him when at its end he is able to make his journey of inspection over the war-ravaged land, now enjoying the blessings of Peace, while he himself finally returns to what he calls the vineyard and the plough to tell us about all these things

One cannot overestimate the value of biography. It reveals the characteristics of a doer and the means through which results perhaps even of great importance have been accomplished. Autobiography has its special interest in that it reveals the estimate a man puts on his own nature and work

The records of the career of great leaders of the past must always constitute a valuable light in marking a path for the beginner of the present. This is peculiarly true of the physician. It was illustrated in a marked manner by Samuel D. Gross, whose two volumes, published nearly fifty years ago, constitute a model of what an autobiography should be. Medical biography forms a large literature, medical autobiography is much less copious. From the slender booklet of Cardan, *De Vitâ Propriâ* (1576) to the bulky volumes of Gross, there are long series of years with no notable example. With Gross begins a new era in our literature, when the busy surgeon lays down his scalpel and takes up the pen of the historian. Marion Sims left us the "Story of My Life." John A. Wyeth in his "With Sabre and Scalpel" gave us the story of the Confederate youth who rode with Forrest in the 'sixties and then came to New York to begin the life of a surgeon. His colleague, Arpad G. Gerster, followed very shortly with his "Recollections of a New York Surgeon," an Hungarian-born scholar who found a place for the fuller development of his qualities in the hospitals of New York City. These were quickly followed by Allan McLane Hamilton with his "Recollections of an Alienist" and by Victor C. Vaughan with "A Doctor's Memories." In 1925, Pilcher joined the list of writers with his "Surgical Pilgrim's Progress." Bland Sutton's the "Story of a Surgeon," 1930, is more recent and has an interest all its own. Doctor Martin's "Joy of Living" forms a notable addition to the library of medical autobiographies.

L S P

MEMOIRS

GEORGE ELI ARMSTRONG

1855-1933

GEORGE ELI ARMSTRONG was born in 1855, at Leeds, Que , the son of Rev John and Harriet M (Ives) Armstrong. He received his early education at public schools, Montpelier Seminary and McGill University and spent



GEORGE ELI ARMSTRONG, M D , LL D , D Sc

several years in study abroad, principally in England, Germany and France. He received his LL D degree at Queen's University and his D Sc degree at Liverpool.

In 1909 he attained prominence when he introduced the use of radium to Canada following a stay in Paris where he studied its possibilities at the Radium Institute. At the time he was surgeon at the Montreal General Hospital, which post he had held since 1890. June 3, 1911, he was appointed chief surgeon of the Royal Victoria Hospital. At this time he was named consulting surgeon of the Montreal General Hospital and of the Verdun Protestant Hospital. In addition to these positions of high standing, Doctor Armstrong was professor of surgery in the Medical Faculty of McGill University, and later dean of medicine of the faculty. He retired from the faculty in 1923. He died May 25, 1933.

During the World War he was Consulting Surgeon to the Canadian Expeditionary Forces. After two years of service he was made C M G by King George.

Doctor Armstrong received many high honors, both here and abroad. In September, 1920, he presided at the tenth annual session of the Clinical Congress of the American College of Surgeons with which he had been connected for some years, having been named president of the college in October, 1919. In 1922 the degree of *Magistra Chirurgia* was conferred upon him by the Dublin University, while in 1931 he was granted an honorary fellowship of the Royal College of Surgeons. Doctor Armstrong was also a past president of the Canadian Medical Association and the American Surgical Association and a past vice-president of the American Society for the Control of Cancer and a member of the International Surgical Association.

He was at one time editor of the Montreal Medical Journal, and was the author of many important surgical papers.

He had a strong and vigorous mind contained in a robust frame. He wrote well and was endowed with power of expression in conversation as in writing, indeed, his clinical instruction was remarkable and won fame for his university. His surgical abilities were outstanding in Canada. He was an unquestionable leader with a strong personality and decided views, generous and hospitable, a most interesting and stimulating companion.

He was always a man of great openmindedness, not only willing but eager to discuss clinical problems with his juniors, possessed of a real humility in science, ready to learn from anybody, and ready to give to anybody whatever knowledge he himself possessed. With regard to the work in the public wards, he was the real hospital man. He spared neither time nor pains with the public patients and he was always kind to them. Towards his juniors on the staff he was generous in giving them opportunities for independent work, and he was always their friend. One of his greatest interests lay in the teaching of students, and throughout his career he possessed the admiration, respect, and the affection of students. Graduates always remembered and spoke of "Armstrong's clinics." This was no wonder, for all his life he burnt much midnight oil in preparing these clinics.

GEORGE ELI ARMSTRONG

He never gave a theater clinic without careful selection of the cases and due preparation for their presentation. To Doctor Armstrong his clinic was the all-important thing and nothing was allowed to interfere with it. It added enormously to his work but he loved teaching and gave unstintingly of his best to his students. That they appreciated his efforts was abundantly proven by the many letters he received from former undergraduates reciting some case in which the remembrance of a clinic had helped them or asking advice in some puzzling case.

One of the chief factors of his success was his attention to detail in operative technic. He was neither a spectacular nor a rapid operator, rather was his work characterized by a deliberateness in which every motion attained its purpose, with the result that no time was lost and the onlooker was apt to be a little surprised at the comparatively short time the operation had occupied.

ABBREVIATED FROM THE CANADA MEDICAL JOURNAL

JOHN CHALMERS DACOSTA

1863-1933

THE death of John Chalmers DaCosta in Philadelphia on May 17, 1933, in his seventieth year, marked the end of a great teaching career. The day of didactic teaching began to wane many years ago and was gradually and



JOHN CHALMERS DACOSTA, M.D.

continuously eclipsed by bedside teaching and instruction to small groups of students. DaCosta was one of the last great didactic and clinical lecturers. DaCosta was a worthy successor to Pancoast, Mutter, the two Grosses and Keen, and, in fact, surpassed them all in this field. His lectures were interspersed with sallies of both homely and classical wit, which were aptly

chosen to drive home some clinical truth. These digressions were usually of a satirical nature and were eagerly and confidently awaited by his audience. His addresses and after-dinner speeches were always hailed with enthusiasm. The mere announcement that "DaCosta will speak" was a guarantee of a large attendance. He was in no sense, however, the habitual after-dinner speaker. I think the necessity of giving these talks was a source of worry to him, but once started and "warmed up" he seemed to enjoy giving free rein to his fertile mind and ready wit. One hearing him talk or reading his addresses might suppose him to be a cold-blooded cynic, but, on the contrary, he was one of the most kindly natures whose sympathies could always be aroused for the unfortunate. Although a cynic, a pessimist, and an agnostic, DaCosta resembled a Dickens much more than a Shaw. He never posed, was always himself and had a deep contempt for affectation and hypocrisy.

He was an omnivorous reader with a remarkable memory. He was particularly fond of Charles Dickens, knew all his characters intimately and quoted them constantly in his conversation, lectures and writings. One often wondered in listening to him how he obtained such familiar knowledge of things which would be supposed entirely out of his ken—such as the beauties of the country, of flowers, of streams and of the woods for he rarely saw them, being as he was a confirmed urbanite. Apparently there were few subjects about which he did not have an intimate knowledge, the result largely of reading and the possession of an unusually retentive memory.

Early in his surgical career (1894) when his time was largely occupied in teaching and in assisting Doctor Keen, he produced a manual of surgery for students, which, with frequent subsequent additions, became a standard text-book and achieved phenomenal success. Probably no such book has ever had such extensive use over so long a period of time. This volume represents DaCosta's most conspicuous contribution to surgical literature, yet forms but a background to his numerous papers and addresses.

Throughout his career he was constantly associated with Doctor Keen and the combination was a very unique one. The contrast between their two natures was ever in evidence, and at times, very amusing. Each admired the other, but aside from surgery, there was little common ground where these two could congenially come together, the deeply religious Keen and the equally sincere agnostic DaCosta.

The termination of DaCosta's career was rendered peculiarly sad by a chronic and painful affliction (arthritis deformans) which soon rendered him incapable of locomotion and deformed his hands so as to make operating impossible and writing very difficult. His triumph over this handicapping affliction was an inspiration to others. For years he was carried from his bed to an automobile, taken to Jefferson Hospital or College, where from a wheel chair, he gave his lectures or conducted his wonderful diagnostic clinics. Most humans in his condition would have been content to remain bedridden, but not DaCosta.

ROBERT WILKINSON JOHNSON

1854-1930

ROBERT WILKINSON JOHNSON, son of William Fell Johnson, and his wife, Ann Mifflin Barker, was born at Rockland, Baltimore County, Maryland, Sep-



ROBERT WILKINSON JOHNSON, M D

tember 8, 1854 His scholastic education was at St Paul's School, Concord, which he left to enter Princeton College in 1873 He received his A B degree from Princeton in 1876 and entered his medical training the same year at the University of Maryland He later transferred to the University of Pennsylvania, receiving his doctorate from that institution in 1879 some eighty-five

ROBERT WILKINSON JOHNSON

years after his paternal grandfather, also an M D of the University of Pennsylvania. The year following his graduation was spent at Vienna in study at the Surgical Clinics there. The field of surgery so rapidly expanding under the impetus of Lister's teachings at once enlisted his unflagging interest and started a lifetime of enthusiastic activity as a clinician, operator and teacher.

He returned to Baltimore to enter practice in 1880 and was in active surgical work until 1915, when angina attacks made relaxation from its ardors imperative.

During this thirty-five years of practice he rose to eminence in Baltimore as a surgeon and as a citizen, gained respect and influence in the wider professional circles of the nation, culminating, in 1905, in his election to membership in the American Surgical Association, and won for himself a position of admiration and affection in the hearts of his students.

His clear logical mind was always a critical one, of himself and his own ideas, quite as much as of others. This critical faculty kept him from many of the pitfalls besetting the onrushing surgery of the period, allowed him to sift wheat from chaff, and, coupled with a pictorial and incisive diction, made him a teacher whose students far outnumbered the actual enrollment.

Always well up to date with the progress of surgery, his own work and his contributions were of a clinical character, as his very active practice and teaching left no time for sustained research. However, his surgical papers or addresses before medical meetings were always carefully thought out and beautifully expressed, a quality which added considerably to his reputation as a scholar.

His sense of noblesse oblige was great, and aside from surgery and professional duties, there were many demands on him, church and state both claiming a share of his time and interest. He was a vestryman of St. Paul's Episcopal Church for over twenty-five years, and gave a great deal of his time to the Maryland Militia and the U. S. Marine Hospital Service as well as other civic duties.

He married Julia W. H. Brock, of Philadelphia, in 1879. They had six children, five of whom, besides his wife, survive him, as do ten grandchildren. Even during the period of his greatest professional activity he was, first and foremost, a family man, and as such probably sacrificed many opportunities to further his purely personal or professional prestige. However, after his retirement to the old family estate at Rockland in 1915, and until his death November 13, 1930, he lived the life of a country gentleman, surrounded by a happy and devoted family, apparently satisfied that his sacrifices were justified.

ROBERT W. JOHNSON, JR.

EDITORIAL ADDRESS

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THE USE OF FASCIA IN RECONSTRUCTIVE SURGERY¹

WITH SPECIAL REFERENCE TO OPERATIVE TECHNIC

BY CHARLES MURRAY GRATZ, M D

OF NEW YORK, N Y

McARTHUR,¹ in 1901, transplanted fascial tissues for the repair of hernia. Since that date, other clinicians have contributed largely to the clinical and experimental work in this field.² Patch transplants were commonly used by the earlier workers and many difficulties were encountered in the securing of permanent viability. Gallie and Le Mesurier³ definitely improved the technic by using fibrous tissue in the form of a suture and they also devised special needles. The introduction of these transplants in the form of sutures reduced the dependence previously necessary on the development of scar tissue alone and hence increased the strength of the transplant and enhanced their viability.

Living sutures of fascial material have been successfully used in many branches of surgery. In gynecology they have been used in the correction of various displacements of the uterus, for the repair of the perineum and cervix, for correction of pleural defects in thoracic surgery and also for the repair of dural defects. In abdominal surgery they have proved successful in the treatment of visceroptosis and in the surgery of the hollow viscera. One of the largest fields in which they are now extensively used is in the repair of the various types of hernia. In plastic surgery fascial sutures have been of aid in the correction of facial paralysis and in congenital torsion of the eyelids as well as in many other deformities. In reconstructive surgery of the bones and joints they have proved their value in replacing torn ligaments, correcting chronic dislocations, reconstructing crucial ligaments and replacing tendons. They have been used in connecting muscles to tendons, including such large tendons as the biceps, hamstrings, quadriceps and tendon Achilles, in tenodesis, in replacing annular ligaments, in the repair of joint capsules, the early reduction of fractures and as a supplement to plastic bone work. In the form of large transplants they have proved invaluable in the reconstruction of joints by arthroplasty.

The fundamental difference between living sutures and prepared ones (either absorbable or non-absorbable), is that the former take an active part in the desired union of the tissues in contrast to the passive rôle of the prepared suture. The time of absorption of the prepared sutures has

¹ Presented before the Society for Plastic and Reconstructive Surgery, October 29, 1932

been found to be variable and they may be absorbed before the desired union of the tissues has taken place with the resultant failure of the operation. This has been frequently found in muscle and tendon work and is particularly the case when absorbable sutures are used in plastic bone surgery. If the sutures are absorbed before there is sufficient callus formation to hold the fragments in place, the muscle pull may result in displacement of the fragments. Delayed absorption, on the other hand, may result in the sutures acting as a foreign body and in their extrusion. Non-absorbable suture material has a tendency to cut out and set up irritation with the resultant danger to the patient. Autogenous sutures, if properly used, not only are free from these disadvantages but have the important advantage—viability. As a result, the strength and elasticity remain unimpaired and they increase the strength of the union besides taking an active part in it. It is now generally accepted that they will grow solidly to bone, muscle and fascia if properly coaptated.

Fascial material is composed of parallel bundles of wavy bands of elastic material, with a fine but scanty tissue stroma binding them together and covered by a connective tissue of rather delicate and loose texture which blends into the surrounding tissues. A liberal supply of blood and lymph permeates the structures.

It is important to remember that transplanted living sutures rely on their nourishment in the host tissues, not on blood but on the lymphatic supply. If any structure is allowed to separate the host and the scion tissue, the death of the transplanted tissue may ensue. This makes it necessary to remove all fat and areolar tissue before transplantation. Trauma to the transplant is to be avoided. The transplanted should be under proper tension with the bone, muscle or fibrous tissue with which it comes in contact. If it is too large or if it is inserted in the form of a tube, the central portion may receive an inadequate supply of lymph and its vitality will be endangered. The fascia unites to its host tissue by means of scar tissue. If the suture tissue is so placed that the entire strain is borne by it, the time necessary for immobilization is much less than if we rely on the scar tissue alone.

When living sutures are used intra-articularly, they are exposed to the synovial fluid of the joints, and the fate of these sutures is of interest. Research along this line is as yet scanty.

In using living sutures an accurate knowledge of their strength and elasticity is of value in determining the size of the suture required and also is of assistance in guiding our technic. In 1930,⁴ the tensile strength and elasticity of human fascia lata were studied with engineering accuracy. Summarizing the results very briefly, the material showed great tensile strength, comparing favorably with soft steel wire of the same weight. It also showed a high degree of elasticity. The maximum tensile strength of the test pieces was 7,860 pounds per square inch. By plotting graphs from test of several specimens it was possible to estimate a safe stress which these tissues would stand without endangering their viability. Taking an average

thickness the breaking tension of a strip of this material three-eighths inches wide is about fifty-five pounds. The optimum load which could safely be applied to such a strip should not exceed sixteen pounds. When it is thought that the load requirement may be in excess of the above, a multiple suture should be used. When a suture is tied in a loop it is equivalent to a single suture of double strength. This work also showed that fascia lata if used within safe stress showed an elasticity of 91 per cent. This high elasticity is an additional factor in promoting accuracy and more favorable results with living sutures.

In planning the operative technic the surgeon should remember that living fibrous tissue is of a soft and slippery nature and is much more difficult to

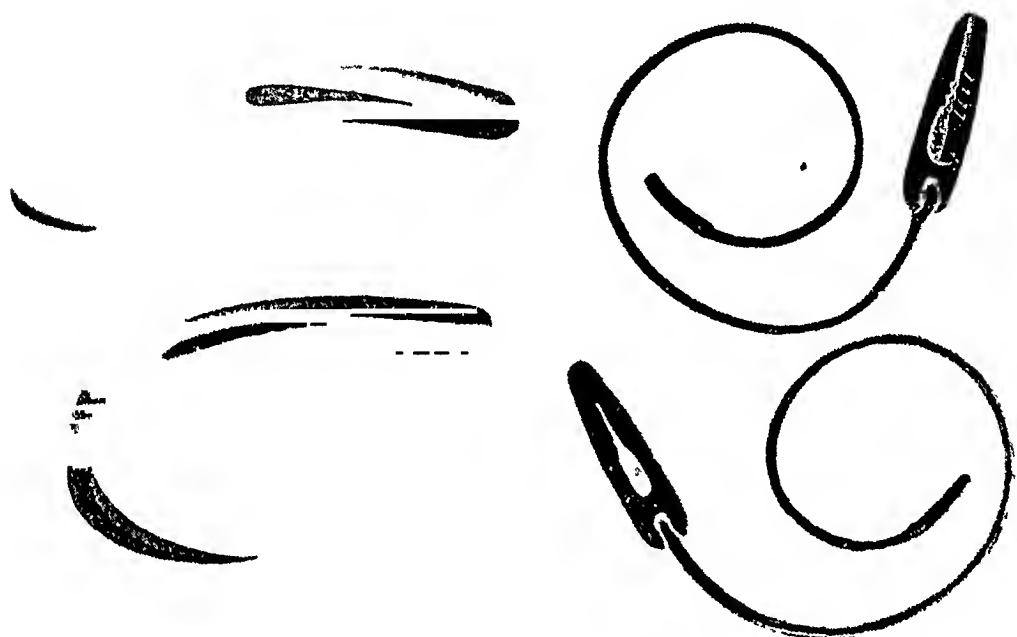


FIG. 1—Fascia needle for use in soft tissues

FIG. 2—Suture threader for fascial suture introduction in osseous tissue

handle than other sutures. To facilitate the use of these sutures in soft tissues, Gallie improved the old-type surgical needle by sufficiently enlarging the eye to accommodate it to the size of the suture. Lane and Austin⁵ added a small loop of wire about one inch in length to the heel of the ordinary needle and threaded the fascia through this loop. Both these needles require overtying the suture to prevent unthreading. There was also bunching in the eye. Both factors increased suture trauma and necessitated a longer suture due to the overtying. In order to further reduce suture trauma and facilitate the introduction and working of these sutures, two new instruments were devised,⁶ one used in the soft tissues (Fig. 1) and a suture carrier for use in osseous structures (Fig. 2). The eye in both these instruments is formed as an elongated wedge with the thin end toward the heel of the needle. The posterior half of the eye is finished with sloping teeth.

the anterior portion remaining smooth. This type of eye permits the insertion of the living material edgewise at the larger anterior end and when tension is applied to the suture it is drawn down to the thin edge of the wedge and securely held in place. This type of eye permits threading of the needle with a minimum waste of suture, holds the suture with a maximum of firmness and entirely eliminates the necessity of overtying. For soft tissues a curved cutting edge needle is used and for osseous tissues a suture carrier was devised with a long flexible leader. This leader may easily be pushed through the drill holes and its flexibility permits the surgeon to insert the suture even if the holes are imperfectly aligned, or are difficult of access.

The flexible leader of the new suture carrier reduces the amount of traction necessary for its insertion, hence a smaller incision may be frequently used. The size of the drill holes need be only slightly greater than the size of the suture carrier. If the drilled holes are not perfectly aligned it may be necessary to make them slightly larger so that the threader will pass without difficulty. When a suture is being placed through the joint it is important to keep the articular edges in firm apposition so that no bone chips enter the joint which may act as foreign bodies and result in damage to the joint later. This is easily accomplished by manual pressure. If a transverse fracture is being sutured, it is better mechanically to place the sutures through the holes in the opposite cortex rather than using the through-and-through suture. This gives better mechanical fixation. All the sutures should be so placed that they will give a maximum correction of the muscle pull which tends to cause an over-riding. The periosteum itself is left in place until the suture is fastened to it. This additional anchorage of the suture gives greater opportunity for the formation of fibrous connective tissue, hence increasing suture viability.

After the holes have been prepared the suture is taken from the saline-moistened gauze, a clamp is placed on the free end grasping a minimum amount of suture, the latter threaded through the holes and the suture thus introduced. A second suture may be placed through the same holes. In certain cases it will be of advantage to use two suture carriers at the same time. An absorbable suture is often placed through the same holes which takes the additional stress until such times as the living suture becomes firmly imbedded in its new position and new fibrous tissue has formed around it.

If the suture be securely anchored at the periphery the main body will of necessity be more securely fastened throughout its entire length and if of the correct size accurate and firm coaptation throughout its entire length will be assured. In anchoring a loop suture a square knot is used, both parts of which are partially overtied with either an absorbable or autogenous suture. The latter suture does not go through the entire living suture but includes up to half of its diameter. In this way there is no danger of inter-

tering with the viability. In anchoring the free end of the suture in the bony structure a single or double knot is tied and the free ends and the knot itself are sewed to the periosteum. In certain cases a second drill hole is made to anchor the suture and adjust the tension. The muscle and soft tissues are sewed in the ordinary manner and drainage is never used.

The entire technic is so devised as to place the entire physiological strain on the suture itself and the osseous structures. If the sutures are tied by absorbable ones alone the suture is weakened. The time of immobilization depends directly on the strength of the internal fixation. In the upper extremity it is possible to start passive motion as early as one week post-operative. Living sutures may also be used to supplement the technic for bone grafts and bone pegs as they have greater resistance to trauma. There is little danger of their being torn by the sharp edges of bone and their viability enhances union between the transplanted and host tissues.

CONCLUSIONS — (1) The operative technic of fascial transplantation is based primarily on the study of the physiology of these tissues.

(2) Fascial sutures will grow solidly to bone, muscle and fascia *if properly coapted*, and will live in these host tissues indefinitely.

(3) The technic herein described has proved clinically to conform with the above requirements.

(4) The new instruments have proved of value in simplifying the operative work.

(5) Research work for the study of tensile strength and elasticity of fascia has been of value in aiding the determination of the proper choice and size of suture best suited for the individual case.

(6) The technic is so devised that the entire stress is borne by the suture itself without relying on the strength of scar tissue. This has permitted earlier mobilization.

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THE REACTION OF THE RETROPERITONEAL TISSUES TO INFECTION

BY HAROLD I MEYER, M D

OF CHICAGO, ILL

FROM THE DEPARTMENT OF SURGERY, OF THE UNIVERSITY OF ILLINOIS

IN THE practice of surgery, one is impressed with the difference in reaction of the body to infections lying in and about the abdomen, following rupture of visci, cholecystitis, appendicitis, pelvis infections and others. He notes that in some cases peritonitis develops, which may be localized or become generalized, usually followed by death. In other cases, there is no violent reaction which accompanies generalized peritonitis, but symptoms and signs of abscess formation are discovered. These abscesses may be successfully dealt with surgically, but only too frequently death follows, due to these abscesses and their sequelæ, septicæmia, pyæmia, pylephlebitis, subdiaphragmatic abscesses, *etc*.

Anyone not familiar with the literature, dealing with the vast amount of experimental work on the reactions of the peritoneum to infections, has himself observed that it has great protective powers. He may also have observed that patients do not so frequently recover from abscesses lying deep in the abdomen.

Believing that the retroperitoneal tissues did not have this special resistive power to infection, in common with the peritoneum, and unable to find an account of any experimental work dealing with this subject, the writer endeavored to ascertain what the reaction of the retroperitoneal tissues to infection would be.

The accompanying studies of the reactions of the peritoneum to infections were made only by way of comparison to the reactions of the retroperitoneal tissues, because exhaustive studies on the peritoneum have been made, serologically, bacteriologically, histologically, and the few peritoneal reactions noted in this work are exceedingly superficial in comparison to the work already done. Our problem is primarily to determine the end-results, whether or not infections of the retroperitoneal tissues carry a higher mortality than infections of the peritoneum.

Much experimental work has been done by Wegner, Chaveau, Gravit, and others, to show that the peritoneum can overcome bacteria without the development of peritonitis and under what conditions exudation and peritonitis do occur. Wegner was the first to study the reactions of the peritoneum in a comprehensive way. He demonstrated that the peritoneum absorbed with impunity a considerable quantity of putrefying material. He also showed that if such material in sufficient amounts could be introduced, death by intoxication might result before the defensive functions of the peritoneum could be mobilized.

If, for any reason, absorption of nonfatal doses was delayed, time might be had for the bacteria to multiply and the peritoneum thus become the site of a

rapidly developing colony Here we find clearly set forth several fundamental factors the possibility of death by the absorption of toxins before reactive factors could be set into action, that is, before peritonitis could develop, that small doses of bacteria might be destroyed before they could do harm, also, that stagnating fluid in the peritoneal cavity would favor the development of bacteria

Much research followed that tended to obscure rather than clarify the real problems Chaveau repeated Wegner's experiments using micrococcus septicus, and he determined that the animals died from absorption of septic products without any obvious changes in the peritoneum Gravitz presented another phase of Wegner's work He noted that when bacteria were introduced, suspended in fluid that was absorbed in a few hours, infection did not follow, but if the fluid stagnated peritonitis developed The processes of absorption and exudation of the peritoneum will not be considered in this work, but a knowledge of these processes should be clearly in mind in order to properly understand the subject of peritonitis

Dogs varying from seven to ten kilograms were subjected to laparotomy under ether anæsthesia Two types of organisms were used, *Staphylococcus aureus* and *Bacillus pyocyaneus*, the latter being used in most of the cases, since a virulent culture of it could be gotten The bacteria grown on plain agar slants were removed by water washings and two cubic centimetres of this suspension were used for the injections

All but two of the intraperitoneal injections were made at the base of the gall-bladder and those two were made at the base of the appendix These sites were also used for the retroperitoneal injections, great care being taken not to contaminate the peritoneum in making the retroperitoneal injections The abdomens were closed The animals were closely watched for all symptoms, which were recorded as were the temperature readings Since these temperatures varied so greatly, far out of proportion to the condition of the animals we found them of little value The normal temperature of dogs is not constant

As soon as possible after the animals died, complete autopsies were performed Those animals, that apparently had recovered from the effects of the injections, were killed after twenty days and complete autopsies performed

A distinctly different type of clinical reaction was observed in those animals receiving intraperitoneal injections from those receiving retroperitoneal injections In the first case, the animal within a few hours would become very sick, have a marked rise in temperature, no desire to eat or drink, nausea and vomiting, irritability, diarrhœa in several instances and prostration The animals that did not die from this acute toxæmia improved fairly rapidly and completely recovered Of the ten cases having intraperitoneal injections, five died and five recovered, those dying all having been injected with *B. pyocyaneus*

Those animals having retroperitoneal injections, with two exceptions, did not have an immediate reaction of acute toxæmia, but after an apparent recovery from the operation, began to fail gradually, as shown by loss of appetite, no desire for water, occasional vomiting, increasing diarrhœa, loss of weight,

going on to extreme emaciation and death. Ten of the twelve animals that were injected with *B. pyocyaneus* and one of the three animals injected with *Staphylococcus aureus* died. The two animals having immediate reactions following retroperitoneal injections were thought to have had peritoneal contamination. They did not die as a direct result of these reactions but recovered, only to die later. Autopsies were performed on all the animals soon after death, except in one case, when it was done on the second day. Here the advanced post-mortem changes made observations valueless. Cultures were taken from the lesions found and from the peritoneal cavities.

There were no deaths from intraperitoneal injections except immediate ones, within five days from the time of injection. No abscesses developed in those receiving intraperitoneal injections and no peritonitis developed in any of those cases, as evidenced by loss of glistening surface of the peritoneum or the presence of exudation at the time of the autopsy. Of the five cases that died, three had sterile peritonea, and all those that lived had sterile peritonea at the time they were killed. Those dying of toxæmia consistently showed marked injection of the liver, spleen, pancreas, kidneys and bowel.

Of the three receiving retroperitoneal injections with *Staphylococcus aureus*, one died with multiple abscesses of the liver, the other two living, these showing no post-mortem findings when killed after twenty days.

Of the twelve receiving retroperitoneal injections of *B. pyocyaneus*, ten died, nine of which had abscesses, retroperitoneally, at the site of injection. One which had a retroperitoneal injection died thirty-three days later, but no abscess was found, or any pathological finding which would account for death. It is significant that nine of the twelve animals receiving retroperitoneal injections should develop abscesses, while none of those receiving intraperitoneal injections developed abscesses or even exudation. In all nine of these cases, *B. pyocyaneus* was recovered from the abscesses, and from three of them the organism was recovered from the peritoneal cavity.

No abscesses of the liver were found in any of these cases except from direct extension from the abscess at the site of injection. Neither were there any instances of gall-bladder involvement, thrombosed portal vessels or signs of pylephlebitis. No abscesses were found in any of the other organs.

The heart was examined in all cases, and in one case, where the animal died seven days following injection, in which a large abscess was found at the site of the injection, abundant vegetations of the mitral valves were found. In four other cases, the valve margins showed some proliferations and in two others there were questionable proliferations.

The average length of life of those animals receiving intraperitoneal injections, which died, was 3.6 days, the shortest time being less than one day and the longest five days. The average for those dying after retroperitoneal injections was 11.1 days, the shortest being one day and the longest thirty-three days.

Experimentally, it has been shown that no deaths occurred from intraperitoneal injections except immediate deaths from toxæmia, and in these three

RETROPERITONEAL INFECTION

out of five had sterile peritonea no abscesses developed, and there were no signs of peritonitis In those receiving retroperitoneal injections, one-third of the cases in which staphylococcus was used developed abscesses, and three-fourths of those in which pyocyaneus was used developed abscesses all of which died These facts, we feel, tend to prove that the retroperitoneal tissues are less resistant to the invasion of organisms than is the peritoneum

CHART

	Staphylococcus 6		Pyocyaneus 19		Totals	
	Intra 3	Retro 3	Intra 7	Retro 12	Intra 10	Retro 15
Abscess	0	1	0	9	0	10
Deaths	0	1	5	10	5	11
Peritonitis	0	0	0	0	0	0
Culture of peritoneum	0	0	2	3	2	3

Days Animals Lived After Injection

Staphylococcus		Pyocyaneus	
Intra	Retro	Intra	Retro
No deaths	7	1	1
		3	2
		4	4
		5	4
		5	7
		—	7
		Av 3 6	8
			17
			28
			33
			—
			Av 11 1

These experiments have a direct clinical application to burying of infected stumps such as after cholecystectomy and appendectomy It is felt that many post-operative abscesses are attributed to this cause, which would not occur should the infected stump be allowed to come into contact with the peritoneum, which can cope with the infection rather than be buried behind the peritoneum in the retroperitoneal tissues which do not have this resistive power This is particularly true of the stump of an infected cystic duct, which is placed in direct contact with a large denuded area

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THE RATIONALE OF THE TREATMENT OF CHRONIC OSTEOMYELITIS WITH SPECIAL REFERENCE TO MAGGOT THERAPY*

BY JOSEPH BUCHMAN, M.D.
OF BROOKLYN, N. Y.

FROM THE SERVICES OF DR. SAMUEL KLEINBERG, HOSPITAL FOR JOINT DISEASES, NEW YORK CITY AND
THE ISRAEL ZION HOSPITAL, BROOKLYN, N. Y., AND THE FIRST ORTHOPEDIC DIVISION, HOSPITAL
FOR THE RUPTURED AND CRIPPLED, OF NEW YORK, N. Y.

"ONCE osteomyelitis, always osteomyelitis" expresses the helplessness of the surgeon from time immemorial in the face of osteomyelitis. Rays of sunshine are now beginning to appear, giving rise to reasonable hope that the problem will in a measure be surmounted in the not far-distant future. This is based, first, upon recent accessions to our knowledge of the pathogenesis of acute osteomyelitis and the dawning realization and dissemination of the observations that early diagnosis and prompt and efficient treatment may abort the long series of tragic events known to all of us only too well. The second factor at the basis of this fond hope is dependent upon recent advances in the technic of the care of the chronic forms of this dread affection. We shall limit ourselves in this presentation to a consideration of the rationale of the treatment of chronic osteomyelitis, and a critical comparison of the basic factors involved in the various forms of therapy now in vogue.

The treatment of chronic osteomyelitis has been haphazard up to recent times. The surgical approach varied from extensive excision of bone shafts to mere incision and drainage and removal of sequestra. The problem of filling the resulting bone cavities gave rise to the development of various bony- and soft-tissue plastic operations and the use of various pastes, semi-solid substances, and even plaster-of-Paris. All of these procedures, however, met with little success.

As a result of the World War, three more or less standardized methods of treatment have been evolved, namely the Carrel-Dakin method, the Orr technic, and Baer's maggot therapy. These procedures with several modifications are now in general use.

Before evaluating these methods, one must pause for a moment to consider the factors underlying chronic osteomyelitis. In the first place, there are disseminated foci of infection and devitalized particles of bone and soft tissue, enclosed by the rigid walled cavities throughout the bones. To eliminate these foci radical bone surgery is essential, indeed, one cannot be too radical. One must, however, respect in so far as possible the epiphyseal plates, the periosteal covering and the circulation of the bone. Once this is obtained by operative interference, one is confronted by a large bone

* Presented before the New Utrecht Medical Society, January 23, 1933.

cavity which must be filled in from the bottom up, by granulation tissue. The second factor underlying this affection is due to the great difficulty encountered in obtaining a satisfactory healing of this cavity. The magnitude of this difficulty is due to unequal healing, resulting in the enclosure of infected foci by the more rapidly forming granulation tissue. Furthermore, it must be appreciated that bone defects heal so slowly that the early formed granulations undergo the changes incidental to scar-tissue formation before the bone cavity becomes entirely filled. It is therefore evident that as cicatrization occurs in the periphery there is a consequential shutting off of the blood supply which stunts further bony growth and prevents complete healing. One may, therefore, be confronted with a possibly well-formed scar tissue at the periphery while in the centre there is a cessation of healing because of an insufficient blood supply. Added to this is the ever-present possibility of re-infection of the indolent tissue in the unhealed portion and lighting up of the enclosed foci previously mentioned.

In view of the above considerations, it appears that the ideal method of treatment of chronic osteomyelitis should have as its basis the following prerequisites: (1) A thorough surgical removal of all diseased parts, (2) some efficient method of sterilization of the surgically formed wound, (3) some method of removal of wound discharges and of the sloughed-off tissues that occur subsequent to operation, and (4) some agent that would produce even and rapid growth from the bottom up, to cause complete filling of the bone cavity before the circulatory changes incidental to scar formation occur.

With these criteria in mind, it is now opportune to examine the effects of the various methods of treatment mentioned above. The Carrel-Dakin, the Orr, and the maggot therapies are all based upon a thorough saucerization of the affected part, that is, a surgical procedure to remove all devitalized bone, overhanging ledges and grossly infected soft tissues. Beyond that, the underlying principles are different.

At the time of the introduction of the Carrel-Dakin method it was thought that the efficacy of the treatment was due to chemical sterilization of the wound. It was subsequently disproved for inert solutions used with the same minute technic produced the same results. It therefore became evident that the value of the treatment is due to physical removal and possibly chemical solution of the wound discharges. This method, therefore, meets only two of the four criteria proposed for the ideal method of approach to the treatment of chronic osteomyelitis, namely, the thorough surgical removal of all diseased parts and the removal of wound slough and discharges. The results obtained are superior to the previous haphazard methods, but the number of failures of healing and recurrences are great. Furthermore, this method causes great discomfort to the patient and is tedious and time-consuming to both the patient and surgeon.

The Orr technic is based upon a thorough surgical removal of all dis-

eased parts. The vaseline pack acts as an efficient method of drainage. In addition, the physical resistance offered by the pack and the physiological rest incidental to immobilization in plaster-of-Paris aid wound healing which must be spontaneous, for there is no active agent to stimulate growth. The infrequent dressings prevent re-infection, but no efficiently active measure is introduced to sterilize the wound. Subsequent to the introduction of the method it was realized that in accordance with the experiments and theories of D'Herelle and Besiedka spontaneous sterilization occurs through the formation of bacteriophages. More recently, Albee has added to this method by attempting to sterilize the wound by the administration of a stock or an autogenous bacteriophage. This method, therefore, meets all of the criteria save the last for there is no provision in this method of treatment for stimulation of growth. Furthermore, sterilization, as the method is commonly used, is spontaneous and therefore haphazard unless the Albee modification is added to the treatment. The application of bacteriophage is not always practicable, because, to be effective, it must be potent and adaptable for the infecting organism. Although there are now a number of phages which are potent for various strains of staphylococcus, there are comparatively few for the streptococcus. It has also been demonstrated that to be effective the phage must be in intimate contact with the diseased part, and that inflammatory exudates, blood serum and blood interfere with its efficacy. The results of this treatment are superior to those of the Carrel-Dakin method. It is more comfortable for the patient, less tedious and time-consuming for the surgeon, but is objectionable because of its offensive odor. There are, however, a considerable number of failures and recurrences and the period of convalescence though shorter than in the Carrel-Dakin method, is nevertheless prolonged.

The maggot treatment meets all of the above-mentioned criteria. First, there is a thorough surgical removal of the diseased area. Second, the wound is actively sterilized by the maggots which physically remove microorganisms by ingestion. Third, the proteolytic activity of the maggot enzymes breaks down the wound discharges and sloughs into end-products, which are then consumed by the maggots. And fourth, the maggots, in crawling about the wound, irritate it sufficiently to stimulate rapid growth. This factor, the importance of which is great in the proper healing of extensive wounds, is possible only with the use of maggots. The results obtained by this method, though not perfect, are superior to either of the previously mentioned techniques, the time consumed in convalescence is considerably reduced and the number of failures and recurrences, in so far as one can judge from observations over several years, are greatly diminished.

A review of the literature on the maggot therapy of chronic osteomyelitis reveals many reports of very high percentages of healing. The period of observation of these healed cases has, it is true, been insufficient to render

final judgment possible, for in no instance has the length of follow-up been over two years. Nevertheless, it is very definite that immediate healing can be obtained in eight to twelve weeks and that recurrences within the period of observation have been unusually few.

Our own experience confirms the above findings. Furthermore, our studies of the character of the healing that occurs under the influence of maggot therapy lead us to believe that in all probability these desirable results will be permanent. We can now reaffirm, and Pomeranz has confirmed the observation that we made in a previous communication, that from the roentgenographical standpoint the healing is very characteristic and highly satisfactory. The affected bones approach the normal in this process of healing in that there is no residual sclerosis or rarefaction, and that the cortices, medullary canals, and metaphyses become reformed and assume a normal appearance. Furthermore, these roentgenographical appearances were confirmed at the operating table. In a number of instances secondary operations were necessary. On each of these occasions we encountered in the healed areas normal-looking bony parts supplied with a rich circulation in contrast to the eburnated or softened areas with deficient blood supply one usually finds in those instances treated by other methods of therapy.

The following two cases are cited to demonstrate the differences in the character of the healing of chronic osteomyelitis treated by the Orr technic and maggot method.

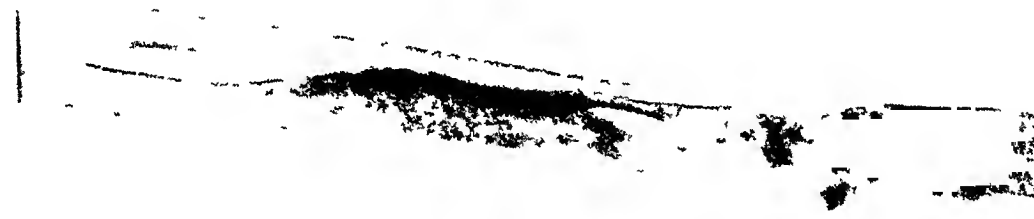
CASE I—R. T., a white male of fifteen years of age, gave a history on admission to the service of Doctor Finkelstein at the Hospital for Joint Diseases that on July 20, 1931, he was afflicted with a sore throat which was soon thereafter followed by an osteomyelitis of the hip-joint. Four days later pain and swelling appeared in the left forearm. This subsided after several days. Two months thereafter and on several subsequent occasions pain recurred. The patient was admitted on February 15, 1932, and within a few days an operation was performed on the left forearm and the Orr technic was carried out. One month later an abscess ruptured spontaneously and drained for twenty-eight weeks. On August 25, 1932, another acute exacerbation occurred and another operation, a saucerization, was performed, and the Orr treatment was again instituted. On November 23 a two-inch sequestrum was removed, and a stock bacteriophage was introduced into the wound. During the early part of January, 1933, the lesion healed clinically, and has remained so to date. There were other osteomyelitic foci in the right hip and left tibia and fibula which were treated by the Orr method on several occasions, and which are still draining. These need not concern us in this presentation.

Fig. 1, an anteroposterior and lateral view of the left forearm taken prior to the first operation, shows an extensive involvement of the radius as evidenced by numerous areas of rarefaction and condensation, an obliteration of the medullary canal, a loss of clearness of the cortex, and the presence of a periosteal reaction. Fig. 2 represents similar views taken one year later subsequent to three operative interferences, and after the forearm was clinically healed. A study of these roentgenograms shows areas of condensation, areas of rarefaction, obliteration of the medullary canal and indistinctness of the cortex.

It is very evident at a mere glance of the latter pictures that the disease process is still present. The clinical healing cannot possibly be permanent for the areas of rarefaction are indicative of enclosed foci of infected granulation tissue, while the areas of condensation and the obliteration of the medullary canal are indicative of deficient cir-



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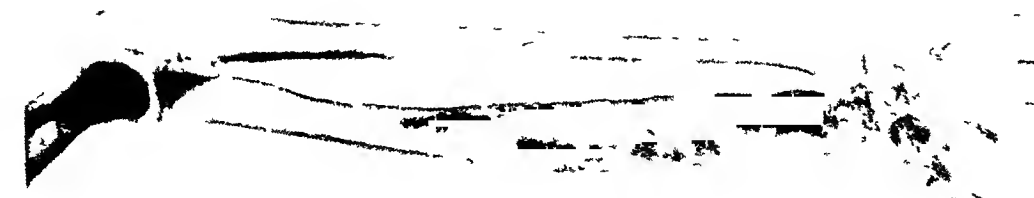


FIG. 1. (a) Showing, near of a reflection and condensation, in obliteration of the medullary canal, a loss of elements of the cortex and a peripolar reaction of the ridges and a peripolar reaction of the ridges (Orr technique), and clinical healing. Showing presence of the α - γ pattern, sub-equal to thick operative inflexion of the medullary canal, and indistinctness of the cortex (b) is evidenced by near of condensation, near of a reflection, obliteration of the medullary canal, and indistinctness of the cortex.

ulation Since experience has shown that healing is never permanent unless the bone regains an approximately normal appearance this case will in all probability be subject to recurrent exacerbations of the osteomyelitic process

In contrast to Case I we cite Case II, which was subjected to maggot therapy

CASE II—A H, a white male of eleven years of age, was admitted to the service of Dr Samuel Kleinberg at the Hospital for Joint Diseases because of multiple foci of osteomyelitis involving both tibia, the left fibula, the right humerus, and a suppurative arthritis of the right knee complicated by multiple deformities and bed sores Several months after the original infection the right humerus became involved, as evidenced by pain, swelling, and disability The pain soon subsided, and recurred thereafter on several occasions over a period of one year during which time no surgical treatment was instituted in so far as the humerus was concerned On September 4, 1931, the writer performed a saucerization operation and instituted maggot therapy Seventeen maggot dressings were applied and notwithstanding that on two different occasions the wound was excessively irritated by the maggot applications, the wound healed completely in four months and has remained so ever since The other foci healed in shorter intervals of time, but they need not concern us here

Fig 3, a roentgenographical study of the right humerus just prior to operation, shows an extensive osteomyelitic lesion as indicated by the presence of areas of rarefaction, areas of condensation, thickening of the cortex, periosteal reaction, and a blocking of the medullary canal Fig 4 is a similar study fifteen weeks later, just prior to the complete epithelization of the wound This picture is characterized by an absence of areas of rarefaction and condensation, a complete filling of the saucerized area which was extensive and involved somewhat more than the upper half of the bone, and a beginning reappearance of the medullary canal The newly deposited bone is smooth and regular in density Fig 5 is a roentgenograph of the same humerus made fifteen months subsequent to Fig 4 The bone is now practically normal in contour, the cortex and medullary canal are well differentiated, and there are no areas of condensation or rarefaction

One cannot but be impressed with the last roentgenogram and no matter how pessimistic one may be, one cannot but be very hopeful that this area will not be subject to a recurrence of the osteomyelitic process The healing is so satisfactory and the reconstruction of the bone is so much akin to that following a fracture that optimism is truly justified

The contrast between the healing process in Case II and that in Case I (compare Figs 5 and 2) is so marked that comment seems to be superfluous The result obtained in Case II has been duplicated in the author's experience so frequently and so universally that no matter how critical and unbiased his attitude and that of his associates has been, they all feel the superiority of maggot therapy, notwithstanding its details and tediousness, to other methods of treatment of chronic osteomyelitis

In view of the data and the many independent reports on hand, it seems justifiable to conclude that the maggot therapy of chronic osteomyelitis has very distinct advantages over other methods of treatment It is the only method which fulfills all of the essentials necessary for satisfactory healing in that it actually stimulates rapid filling of the wound in addition to sterilizing it and emptying it of discharges and debris The character of the healed

MAGGOT THERAPY OF CHRONIC OSTEOMYELITIS



FIG 3—(Case II) Right humerus showing an extensive osteomyelitic lesion as indicated by the presence of areas of rarefaction areas of condensation thickening of the cortex periosteal reaction and a blocking of the medullary canal

FIG 4—(Case II) Fifteen weeks after operation and subsequent to maggot therapy and just prior to epithelization of the wound. Showing absence of areas of rarefaction and condensation complete filling of the saucerized areas and a beginning reappearence of the medullary canal. The newly formed bone is smooth and regular in density

FIG 5—(Case II) Fifteen months subsequent to Fig 4 showing practically normal contour of the bone cortex and medullary canal are well differentiated no areas of condensation or rarefaction

JOSEPH BUCHMAN

bones is more nearly normal than that resulting from any other procedure, for there is no residual sclerosis or rarefaction and there is in addition an actual reformation of the bony parts. The maggot therapy has now gained recognition in many quarters and the resulting accumulation of trustworthy independent observations attest to its efficacy in the treatment of chronic osteomyelitis.

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THE PROBLEM OF RECURRENT HERNIA*

BY CALVIN M. SMYTH, JR., M.D.

OF PHILADELPHIA, PA.

IN THIS paper the term hernia is applied to the inguinal variety. Hernia or "rupture" is one of the oldest recorded ills to which the human body is heir and with few exceptions all of the "fathers of medicine" have somewhere mentioned it. The earliest recorded attempts at operative correction are credited to Celsus. Ambrose Pare practised removal of the sac, as did other surgeons of his period and even today a few adhere to the dictum that high removal of the sac is the only factor of importance in the successful radical cure. The modern conception of the surgery of hernia dates from the work of Bassini in Italy and Halsted in this country. Following the introduction of the Bassini operation in 1889, it was unreservedly announced, and apparently accepted, that the problem of hernia had been solved. While the value of Bassini's contribution must not be underestimated, it is nevertheless true that there was about as much truth in the foregoing statement as in Pare's assurance in the sixteenth century that surgery was finished. The complacency with which surgeons everywhere had come to regard their results in hernia operations was rudely shaken with the advent of that great iconoclast the Follow-up Clinic. It soon became apparent that every surgeon who operated upon hernias failed to cure some of his patients and by this is not meant those patients in whom the result was obviously unsatisfactory at the time of discharge from the hospital. The percentage of recurrences stimulated a number of surgeons to carefully examine and inquire into the reasons for this state of affairs, although it was with no little amazement that the writer learned when requesting information regarding the recurrence rate in one of the largest surgical clinics in this country, that no figures were available.

Lahey, over a ten-year period (1919-1929), reported that out of 394 patients operated for inguinal hernia, 150 patients returned for follow-up examinations, thirteen, or 8.7 per cent, of these patients had recurrences. Further analysis of this group of patients shows that the rate of recurrence in bilateral hernioplasty is higher (18.1 per cent). Direct hernias had a recurrence rate of 7.8 per cent, while the indirect had 4.6 per cent. Regarding the type of operation employed, Lahey states that the greatest number of recurrences (11.7 per cent) occurred following repair with autogenous fascial sutures.

Turner Thomas states that the recurrence rate in operations for inguinal hernia is 7.46 per cent for all types: in direct hernia, 16.61 per cent recurred, while for the indirect group the rate was 3.15 per cent.

* Read before the Philadelphia Academy of Surgery, March 6, 1933.

PROBLEM OF RECURRENT HERNIA

In a paper unfortunately never published, the late George G. Ross reported in 1921, 132 consecutive inguinal hernioplasties without a recurrence. These cases were all examined by Doctor Ross and the writer. This is of considerable interest in view of the fact that Ross invariably did the Ferguson operation, which is now considered inferior to many other procedures. It suggests that the type of operation is of secondary importance when compared to the skill with which it is carried out.

Impressions, while in a measure unreliable, are of some value, and when one surgeon of large experience states that in something over 700 hernioplasties in children, he can recall but three recurrences, due consideration must be given. Certain it is that the problem is vastly different in children than in adults and that conclusions drawn from an experience largely confined to these young patients do not apply to the problem in general.

With this introduction it is now proper to consider specifically and in some detail the factors which contribute to recurrence following radical operation.

(1) *Selection of Patients for Operation*—In patients whose tissues are obviously bad material with which to work, either as the result of constitutional disease, excess fat, advanced age, etc., the healing powers are greatly reduced and an unsatisfactory result must be expected. In patients otherwise fit, focal infections, chronic upper respiratory disease with habitual cough or prolonged coagulation time, the chances of failure are definitely increased and operation is best deferred until the condition is remedied.

(2) *Choice of Anæsthetic*—While hernioplasty is usually an elective procedure and not one calculated to produce shock or other disturbing complications, inhalation anæsthesia doubtless contributes factors making for failure, such as post-operative itching and vomiting, the exaggeration of a quiescent bronchial condition with the production of cough and the consequent strain placed upon the site of operation. Local or spinal anæsthesia would appear to be advisable in cases where the slightest doubt exists.

(3) *Nature and Extent of the Operation*—Regardless of the specific technic employed, all hernia operations have two points in common, namely, ligation and removal of the sac and obliteration or reconstruction of the canal. The first of these may be dismissed briefly. The only difference of opinion lies in the value of the various methods of transplanting, transposing or anchoring the stump of the sac, in contrast to simply dropping the stump and allowing it to retract beneath the muscles. Concerning the treatment of the canal, much more must be said. This may best be appreciated by an analysis of the various steps involved in the Bassini operation, especially since this operation or some modification of it is more universally practised than any other form of hernioplasty. The essentials of the Bassini operation are (a) The high ligation and removal of the sac, (b) the obliteration of the inguinal canal by suturing the internal oblique (or the conjoint internal oblique and transversalis) muscle to the shelving margin of Poupart's

ligament beneath the spermatic cord, (c) the suture of the aponeurosis of the external oblique above the cord and the closure of the skin. It is readily seen that this operation totally disregards certain anatomical factors of importance.

The component parts of the body are held together by fibrous connective tissue in the form of ligaments and fasciæ. In the retention of the abdominal contents the most important structures are the transversalis or endo-abdominal fascia and the aponeurosis of the external oblique. The muscles are of secondary importance. In indirect inguinal hernia, the openings in these fasciæ are the two chief points where, if incompetence exists, the major invitation to hernia occurs. It therefore follows that the transversalis fascia and the aponeurosis of the external oblique are the structures entitled to the major consideration in any operation for the cure of hernia. The Bassini operation completely ignores the transversalis fascia at the internal ring or elsewhere, and the aponeurosis of the external oblique is incised to permit access to the hernial sac and in the reconstruction it is merely sutured together, restoring the same condition which existed prior to the operation. Another fundamental defect in the Bassini operation is the assumption that red muscle will permanently fuse with white fascia when the two are approximated by suture. That this is a fallacy has been demonstrated by Koontz, Edmund Andrews and others. The fact that the number of recurrences after hernia operations is not greater may, in the light of our present knowledge, be used to support the contention of Russel that high removal of the sac is the only important step in hernioplasty, and this is probably true in the simpler hernias in adults and in practically all hernias in children. It is the complicated hernia, however, that engages our attention and which is the one prone to recur.

The Stettin operation was conceived with the idea of eliminating some of these inadequacies of the Bassini operation and while constituting a definite advance, nevertheless failed to consider all of the points mentioned. For a time the writer employed the Stettin technic in almost every case, but was led by three failures to assume a more critical attitude. The disadvantages of this operation are that the transversalis fascia and the internal ring are disregarded, that red muscle is sutured to white fascia, that the obliquity of the canal is destroyed by placing the new external ring opposite the internal ring, and, finally, that the transverse incision required in order to suture the aponeurosis of the external oblique about the cord leaves a definite weak point in the fascia and constitutes an invitation to recurrence. It was at this point that the three recurrences mentioned occurred.

Failure to consider the facts enumerated above must inevitably be responsible for many unsatisfactory results.

Suture material becomes a matter of minor importance when we remember that the ultimate union is of the tissues themselves, the function of any suture being to temporarily hold in apposition the structures until the normal healing process has been completed, and having served that purpose, has

done all that it can do Sutures placed into tissues under tension defeat their own purpose by pressure necrosis and the subsequent separation of the structures they attempt to hold together Therefore, it would seem to make little difference in the ordinary case whether one uses plain or chromicized catgut, kangaroo tendon, autogenous or preserved fascia, or silk

In those cases where there has been such disturbance of the normal relations as to produce actual defects, we are faced with a different problem Here no approximating suture as such can accomplish anything, for, as we have stated the tension under which such sutures must be placed defeats the objective It is in the repair of such defects that the fascial suture is of great value, although the term suture is a misnomer, as what is really done is to weave or darn the fascia into the structures bounding the defect and not to draw those structures together The original use of fascia by McArthur is quite different from that described at a later date by Gallie and LeMesurier McArthur used a strip of fascia taken from the aponeurosis of the external oblique left attached at one end the free end being threaded upon a needle and used to suture the conjoined muscle to Poupart's ligament Gallie and LeMesurier used strips of autogenous fascia lata for the bridging of defects and demonstrated the difference from and the superiority to free fascial grafts for this purpose The use of ox fascia preserved in alcohol advocated by Koontz has the advantages of unlimited supply and the elimination of another operation for obtaining the sutures Although some of the difficulties first encountered with ox fascia have been overcome it would appear that the liability to infection and necrosis is greater than when autogenous fascia is used Experimental evidence also indicates that autogenous fascia becomes permanently incorporated in the tissues while the ox fascia is eventually absorbed There would appear to be little indication for the routine use of any fascial suture in the performance of hernioplasty for indirect inguinal hernia or in direct hernia unless there exists a defect which cannot be repaired by simple suture without tension

It is not the writer's purpose to advocate a particular operation for every case but to suggest that a rational hernioplasty should include the following

- (1) Closure of the internal ring
- (2) Preservation of the obliquity of the inguinal canal
- (3) The suture of fascial structures to each other and not of fascia to muscle

The operation which we have come to employ routinely in inguinal hernia, whether direct or indirect, is carried out along the lines suggested by Edmund Andrews, "white fascia operation," with certain modifications The canal is opened and the sac treated in the usual manner The transversalis fascia is then sutured to the shelving margin of Poupart's ligament from the internal ring to the spine of the pubis using interrupted sutures of No 1 chromic catgut placed about one centimetre apart The conjoined muscle is disregarded The mesial leaf of the external oblique aponeurosis is then sutured to the shelving margin beneath the cord Andrews, at this point, roofs over

the cord with the lateral or lower flap of aponeurosis. This seems to us an unnecessary step and wastes valuable fascia that might be put to better use. Our practice is to suture this leaf or flap to the mesial flap beneath the cord, thus giving one more fascial reinforcement to the canal. Two or three interrupted sutures bring the mesial flap over the cord in the upper angle, to preserve the obliquity of the canal. Placing of the cord immediately beneath the skin has caused no unpleasant symptoms in our experience. Sutures of fascia lata are used in all cases where the patient's own fasciæ are inadequate and routinely to close the larger defects at the site of a direct hernia.

Post-operative Treatment—The immediate post-operative management of hernioplasty need not differ from that of any abdominal section except that the patient should be kept flat for a somewhat longer period. As to the length of this period some difference of opinion exists but it varies in different clinics from twelve to twenty-one days. Rigid dressings are no longer employed by many. The removal of skin sutures should be made as in any other operation since the skin wound has no bearing upon the integrity of the operation. Wound infection is a distressing post-operative complication as it may destroy the result of a mechanically perfect procedure. Therefore, all precautions must be taken to guard against it. Hæmostasis must be rigid and provision made at operation for the escape of serosanguinous fluid before the wound is subjected to pressure. A few strands of silkworm gut placed in the wound for twenty-four hours do no harm and may be the means of preventing trouble. Other matters such as cautioning the patient against too early return to strenuous occupations and particularly against lifting heavy objects while the knees and hips are in flexion (squatting position) are of course, to be considered.

From the foregoing observations certain conclusions may be properly drawn.

(1) The rate of recurrence following inguinal hernioplasty is higher than was thought prior to the institution of follow-up clinics.

(2) The Bassini operation as usually performed is an inadequate procedure, principally because of the failure to consider certain, now established, anatomical and physiological facts.

(3) Not one factor, but several, must be borne in mind in improving the results of operations for radical cure of hernia.

GUNSHOT WOUNDS OF THE ABDOMEN

A REVIEW OF TWENTY-TWO CASES

BY DUVAL PREY, M D , AND JNO M FOSTER, JR , M D
OF DENVER, COLO

FROM THE SURGICAL SERVICE OF THE DENVER GENERAL HOSPITAL

TWENTY-TWO patients suffering from gunshot wounds of the abdomen, who later received the benefit of surgical intervention, were admitted to the Denver General Hospital during the period, 1928 to 1933. The mortality rate in this series was 68 per cent, which corresponds with similar statistics as reported in the literature from other general hospitals throughout the United States. Loria⁸ reports 122 cases observed at the New Orleans Charity Hospital, with eighty deaths, Mason,¹⁰ of Birmingham, records thirty-three deaths in fifty-eight cases, while Condict,² of New York City, had nine deaths in twenty cases. These statistics when compared with those reported by Crawford,⁴ in 1910, indicate that the mortality rate for similar injuries has not been appreciably improved in the last two decades. The extremely slow progress that has been made in the treatment of these injuries is further emphasized by an historical review.

In civil life, bullet wounds of the abdomen first became prevalent through the custom of pistol dueling. At that time surgery was indicated only when the abdominal contents had eviscerated. Later, during the War of the Rebellion, the mortality rate for penetrating wounds of the abdomen was found to be approximately 90 per cent, because surgical intervention was instituted only when the hæmorrhage was too profuse to be controlled by bandages. In such circumstances, the procedure consisted simply in enlarging the abdominal wound and ligating the bleeding vessel. It was not until the Spanish-American War that an effort was made to completely repair the intra-abdominal damage, and then only five cases were given the benefit of operative interference. During this period the mortality rate was variously estimated at 80 to 90 per cent. However, by 1910, surgical repair was generally accepted as the proper mode of treatment, and, as a result, the mortality was immediately reduced to approximately 60 per cent, a figure at which it now stands.

The three predominant factors determining the gravity of gunshot wounds of the abdomen are (1) the degree of visceral damage, (2) the amount of hæmorrhage, and (3) the time elapsed from the injury to the completion of its surgical repair. With this idea in mind, a chart is presented of all cases of gunshot wounds of the abdomen receiving the benefits of an operative procedure, which were admitted to the Denver General Hospital during the past five years.

The first factor, namely, the mischief caused by the bullet's course through

the abdominal cavity, must of necessity remain outside the realm of surgical control, and for this reason certain injuries will always command a high mortality rate. For instance, a wound of the hollow viscera is more dangerous than is a like injury to a solid organ, and a tear in the liver or spleen is not as hazardous as is one of the pancreas, while a perforation of the stomach and small intestine is less serious than a similar injury to the large bowel. Further, the more numerous the perforations, the more difficult is then isolation and suture, and the greater is the resulting risk.

CHART I
Gunshot Wounds of the Abdomen

Case Number	Time from Injury to Operation in Minutes	Operating Time in Minutes	Total Time in Minutes	Pathology	Hæmorrhage	Recovered	Died	Transfusion	Time from Injury to Transfusion in Hours
34059	115	55	170	Perforations of Colon	----	X		0	0
34710	190	97	287	Perforations of Colon	--		X	0	0
36639	120	58	178	Perforation of Stomach & Pancreas	--	X		0	0
38095	150	60	210	Perforation of Colon	?		X	0	0
38664	90	48	138	Perforations of Jejunum	?	Y		0	0
40039	110	50	160	Perforation of Ileum & Colon	---		X	0	0
44787	207	64	271	Section of Ureter	----		X	0	0
46081	115	45	160	Perforations of Ileum	?		X	0	0
46700	420	40	460	Perforations of Ileum	----		X	0	0
60496	102	58	160	Perforations of Ileum	?	X		0	0
61454	68	63	131	Perforation of Stomach	----		X	0	0
61703	94	56	150	Perforation of Liver & Stomach	--	X		0	0
62461	260	50	310	Perforation of Liver	?		X	X	16
64697	258	125	383	Perforations of Ileum	---		X	X	6
72912	510	30	540	Perforation of Liver & Kidney	--		X	X	20
73304	187	57	244	Perforation of Liver & Stomach	---	X		X	10
76082	80	70	150	Perforations of Ileum	?		X	X	24
76975	195	65	260	Perforations of Ileum	--		X	0	0
79868	164	143	307	Perforations of Ileum	----		X	0	0
81132	85	50	135	Perforation of Stomach	---	X		X	5
85171	140	65	205	Perforations of Ileum	?		X	0	0
85173	195	95	290	Perforation of Colon	--		X	0	0
				Summary					
Average	113	55	168			32%			7 1/2
Average	191	70	279				68%		18 1/2

The second factor, that of hæmorrhage, is partially under surgical control, and according to many authorities^{1 3 5 6 7 9 11} is frequently disregarded because of a general inappreciation of its significance. Mason, of Birmingham, suggested, after a study of many case records, that the shock present in these injuries was the direct result of the hæmorrhage. If this statement is accepted, then it furnishes additional evidence in favor of the value of early surgical intervention. Six of the cases reported in this paper received one or more transfusions, but due to delay they were often given too late to be of any real value. The average time in this series, from the injury to the transfusion, was fourteen hours.

The third, or time factor, is definitely under our control, but is often neglected. We know that the mortality rate in a ruptured peptic ulcer increases in inverse ratio to the time elapsed after the accident. We also know that the course of a bullet is frequently most fanciful, and because many of these patients are in a most excellent condition upon our first examina-

tion, we delay surgical intervention until such symptoms have arisen, which by their very presence, indicate the patient's condition to be hazardous. Cases Nos 61703 and 61454 furnish excellent examples of the splendid condition in which a patient may appear with a gunshot wound of the abdomen.

Case No 61703 is that of a seamstress, aged fifty-two, who was shot by her husband during a drunken quarrel. The bullet entered the left upper quadrant of the abdomen and lodged in the musculature of the back near the ninth dorsal vertebra. Upon entrance to the hospital, approximately thirty minutes after her injury, she was in practically no shock, with a pulse rate of 78 and a temperature of 99.4° F. The abdomen showed a small puncture wound just below the left costal margin in the mid-clavicular line. There was no distention present, and only a slight splinting of the muscles near the wound, with moderate dullness in the left lumbar gutter. The patient had not vomited and was having no pain. An immediate operation was performed, and the bullet was found to have transversed the left lobe of the liver, and penetrated both walls of the stomach.

The second case, No 61454, demonstrating this same phase, is that of a man, aged twenty-eight, who had been on a drinking bout at a friend's home, and because he expectorated upon the rugs, he was shot through the abdomen at close range. When he entered the hospital, which was forty-five minutes following the accident, he was not in appreciable shock, was very talkative, and on examination showed a penetrating wound in the epigastrium, and dullness in both lumbar gutters. At the subsequent operation, which was performed immediately, the bullet had passed through both stomach walls, with its point of exit to the right of the vertebral column.

The time elapsed before the operation is performed is of vital importance, as is clearly shown in this series. (See chart.) The average time for this period in those cases that lived, was one hour and fifty-three minutes, while for the cases that died, there was more than one full hour longer of delay, or an average pre-operative time of three hours and eleven minutes. This factor is generally understood, but the danger of even the slightest delay is not fully appreciated. These patients represent real surgical emergencies, and must be respected as such if we desire to improve the excessive present-day mortality rate. Further, the same procrastination must be absent from our surgical procedure. The quickest, easiest, most logical, and surest method of repair will give the most satisfactory result.

This fact is demonstrated most forcibly by an analysis of the operating time in each case. The average operating time for the cases terminating fatally was one hour and ten minutes, four cases only, consuming less than one hour, and in four instances the procedure required over one hour and thirty minutes. The average time consumed by the surgery in the cases that survived was fifty-five minutes, and none required over one hour. For the two individuals that lived one week and two weeks, the surgical procedure occupied fifty minutes and one hour and ten minutes respectively. It is also interesting to note that every case necessitating resection of the intestine died. It is frequently suggested that in dealing with perforations in the small intestine, it is easier, simpler and therefore quicker to resect that segment of gut, than it is to suture the wounds separately. This is occasionally true, but only rarely, particularly if a lock stitch is used for the repair.

of the larger perforations. This suture has the advantage of giving a most satisfactory closure and requiring a minimum amount of time for its execution. Of course, the time consumed for the surgical repair depends largely upon the extent of the intra-abdominal damage, but with a more general appreciation of the necessity for expeditious surgery, every possible means of surgical knowledge will then be utilized to serve this purpose.

It is certainly most pertinent that in this entire series not one of the patients who recovered had a surgical procedure requiring more than one hour's time to complete. Too much emphasis cannot be placed upon the single factor that a supreme effort must be made to complete the surgical repair within this time.

To this end this paper is dedicated, that we may have a more definite and systematic mode of care, which will alleviate delay and thereby bring to a more happy conclusion many of the cases of gunshot wounds of the abdomen. To delay is to destroy, and unless we are absolutely familiar with the most rapid method of attack and repair many of our cases must necessarily be doomed to failure.

With this idea in mind the following tabulated suggestions are made as a means of obviating a few of the petty delays which are encountered in the treatment of these cases.

(1) In most cities, patients suffering injuries of this nature are cared for in the general hospitals and usually are promptly transported to the emergency room. The interne then notifies the staff officer and awaits his arrival and subsequent examination before ordering the operating room to be prepared. When it is appreciated that even the loss of one-half to one hour is of paramount importance to their successful outcome then only will the internes be encouraged to order the operating room immediately upon the arrival of the patient in the emergency ward.

(2) At the same time that the notification to the staff surgeon is given, the house interne should begin the necessary arrangements for a transfusion. This can seldom be accomplished under one hour's time but if the preparations have been started early the transfusion frequently can be given before the surgical procedure, and if not, immediately upon its completion. According to many authorities those cases showing moderate to severe bleeding have a higher mortality rate than those with only slight hæmorrhage. The procedure of transfusion then becomes of prime importance to their proper surgical care.

(3) The degree of shock present, whether it is due to a loss of blood volume, the result of an increased permeability of the capillaries, dehydration, or hæmorrhage, must be treated immediately, and to this end an intravenous infusion should be started at once. The patient should be placed on shock blocks, and external heat applied. This phase of the surgical treatment is seldom neglected, and the desire of this paper is only to emphasize the value to be obtained by its immediate application.

(4) The size of the incision must be sufficiently ample to permit easy

GUNSHOT WOUNDS OF ABDOMEN

visualization and exploration of the abdominal viscera. Fortunately, it no longer is an indication of good surgical technic to work through small, button-hole like incisions, but even so, the tremendous advantages of a liberal wound are not fully appreciated. Nothing so facilitates an easy and rapid surgical procedure, and as a careful exploration is an absolute necessity in this type of injury, the incision must be generous enough to easily permit its performance. Further, it is an accepted fact that a large wound shows no greater tendency to hernia formation than does a small one, and as our desire is to repair the damage in the least possible length of time, then we must necessarily have an ample incision in order to accomplish this objective.

(5) Because hæmorrhage is always present, and an accumulation of blood will uniformly be encountered upon opening the abdomen, a satisfactory apparatus for suction should be at hand for immediate application upon entering the peritoneal cavity.

(6) In the event the bullet has penetrated the liver, the operative procedure is simply to control the subsequent hæmorrhage resulting from the laceration of this organ. Although there are numerous means suggested for suturing the liver, all are time-consuming, and it has been shown most clearly that tamponade alone will prove sufficient. As our desire is to accomplish the control of the hæmorrhage in the shortest possible time, then packing should be utilized for this purpose in every case where a solid organ has been injured. It has been suggested that a packed liver is prone to subsequently develop an abscess. This danger undoubtedly has been greatly exaggerated, because not only in this series but in the last fifteen years, at the Denver General Hospital, autopsy records fail to reveal the presence of a single liver abscess resulting from tamponade.

(7) Should the bullet have pierced both stomach walls traveling from before backward, it will regularly be noticed that the wound in the anterior wall is small, while that in the posterior is much larger. By enlarging the opening in the anterior wall by means of a linear incision in the direction of the long axis of the stomach, the posterior wound may be sutured through this incision with comparative ease. The readiness with which this may be consummated in comparison to suturing the tear in the posterior wall of the stomach by an approach through the mesocolon is most astounding.

(8) Large tears of the stomach or bowel frequently present difficulty in closure. In our experience we have repaired these wounds by means of a lock stitch in preference to the Lembert suture, because of its comparative ease and rapidity of execution, and not once have we regretted its employment. This is accomplished by placing two Allis forceps at each angle of the wound, one near the mesenteric border of the intestine, and the other directly opposite, then by means of a continuous lock stitch, the wound can be sutured both rapidly and snugly. In repairing the stomach, the direction of the suture line should be in its long axis, except when it might interfere with the lumen at the pylorus.

(9) Frequently when the intra-abdominal damage has been most severe, and its repair necessarily time-consuming, we can facilitate the incisional closure by utilizing the method of approximating all layers with heavy through-and-through silk sutures. This method of closure has been used frequently enough in our own experience, as well as that of others, to justify its practice in every case when a rapid closure is essential.

The above suggestions have been offered as a means by which we may obviate some of the more common delays encountered in the treatment of gunshot wounds of the abdomen. There is no implication intended that they represent the only impediments to a brisk and speedy recovery, but it is hoped that by pointing to the more obvious hindrances to an expeditious surgical care, further study will be stimulated, to the end that the employment of immediate, rapid surgery will subsequently reduce the embarrassing present-day mortality rate.

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EXPERIMENTAL STUDIES IN NERVE TRANSPLANTS*

By LOYAL DAVIS, M D , AND DAVID A CLEVELAND, M D
OF CHICAGO, ILL

FROM THE DEPARTMENT OF SURGERY OF THE NORTHWESTERN UNIVERSITY MEDICAL SCHOOL

DURING the development of the surgical treatment of peripheral nerve injuries many methods of surgical repair have been described. These methods are all alternative to the method of choice, which is, of course, direct end-to-end suture of the nerve ends. Unfortunately, all of the suggested procedures are not based upon established physiological, histological or anatomical principles. The mass of experimental and clinical evidence which has accumulated concerning these methods, particularly during and since the Great War has been analyzed and evaluated rather accurately. Such analyses only emphasize the wide gap which exists between the functional results obtained by end-to-end nerve suture and those which follow the most successful of the alternative methods of repair.

There are many times when the ends of the divided nerves cannot be approximated easily and several procedures have been advocated in order to obtain an end-to-end union. Flexion or extension of neighboring joints, gradual liberation of the nerve trunk from its normal bed, gradual stretching, transposition of the nerve from its normal bed to a shorter anatomical course, or a combination of these procedures may bridge gaps as large as seven to eight centimetres.

There are instances, however, in which all efforts to effect an end-to-end suture fail. Several surgical procedures have been suggested for the repair of these large defects in nerve trunks. These operations may be classed as (1) nerve implants, (2) nerve flaps, (3) suture a distance, (4) tubulization, (5) nerve crossing and (6) nerve transplants or grafts.

Nerve implantation signifies the placing of the proximal end of the distal segment of a divided nerve into the substance of a sound nerve through a slit-like opening in the endoneurium. This method was devised by Létievant,¹ in 1873, and has been frequently used in Germany particularly since Hoffmann² advocated it so strongly in 1884. Critical analyses by Stookey³ and Pollock and Davis⁴ show that the good results obtained are due to nerve crossing and not implantation. If the funiculi of the sound nerve are spread and the implanted nerve placed between them there are no anatomical nor physiological reasons why an uninterrupted neuraxon should enter the implanted stump. On the other hand, if the axis cylinders of the sound nerve are cut in the process of implantation these may very likely grow into the implanted nerve.

The nerve-flap operation also described originally by Létievant, in 1872,

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involves the turning of a flap of part of the nerve from the central or distal end to bridge the defect. Regardless of the source of the flap no neuraxons connected with their cells of origin can be in apposition with the distal segment. This operation received considerable attention because of the reports of successful cases by Tillmanns⁵ and Mackenzie⁶ but from his review of their cases Stookey⁷ has presented positive evidence that regeneration had not occurred. The experimental work of Huber,⁸ in 1895, is further proof of the futility of this operation.

In 1886, Assaky⁹ proposed the operation of suture a distance as a method of supplying a scaffolding of sutures between the cut nerve ends along which neuraxons might grow to reach the distal segment. Although Huber obtained some evidence of regeneration in two instances, the majority of clinical and experimental evidence does not support this method. The danger of a barrier of dense connective tissue and the uncertainty of the scaffolding should be sufficient to question the logic of this procedure.

Tubulization has been suggested many times since Gluck¹⁰ used the central canal of a decalcified bone drain to form an uninterrupted pathway between the separated ends of a divided nerve. Various types of tubular structures, including rubber tubes, rolled gauze, fat and fascia sheaths, hardened and fresh blood-vessels, and hardened gelatin, have been used, but most of the clinical and experimental evidence lends little support to this method.

Nerve crossing, often called anastomosis, dates back to 1828 when Flourens¹¹ successfully crossed the median and radial nerves. The experimental and clinical results speak for histological and functional regeneration when nerves of like function are united. Philipeaux and Vulpian¹² succeeded in joining the lingual and hypoglossal nerves and concluded that functional regeneration will occur between sensory and motor nerves. Histological studies made by Langley and Anderson¹³ demonstrated that fibres will grow from the anterior crural nerve into the external saphenous. Similarly, Boeke¹⁴ was able to follow fibres from the hypoglossal through the lingual to the epithelial layers of the tongue. Although these experiments show that histological regeneration of neuraxons may take place between sensory and motor nerves there is little evidence to demonstrate the return of functional activity. It may be stated that crossing of nerves of similar function has a distinct place in the surgical treatment of nerve lesions. There are a large number of cases reported in the literature in which successful results have been obtained. Reference need be made only to the excellent functional results obtained by innervation of the facial muscles when the hypoglossal or other cranial nerves are joined to the distal end of the facial nerve following facial paralysis.

Nerve transplantation, or grafting, in humans dates from 1878 when Albert used a nerve from an amputated limb to bridge a three-centimetre gap following the removal of a sarcoma from the median nerve. Primary union took place but no further report of the clinical course is available. In a second case the transplanted ten centimetres of the posterior tibial

nerve to fill in a defect in the ulnar after a neurofibroma of that nerve had been resected. There was a complete slough of that transplant. In 1880, Kaufmann bridged a gap in the radial nerve with a graft from the sciatic nerve of a dog. The first entirely successful nerve graft reported is that of Mayo-Robson,¹⁵ who, in 1888, transplanted 2.5 centimetres of the posterior tibial from an amputated limb between the separated ends of the median nerve. In 1906, Sheiaren¹⁶ collected reports of eight cases from the literature of auto- and homogeneous transplants in only three of which had sufficient time elapsed after operation to admit of recovery. Of these, two recovered completely. He also reviewed the reports of twenty-two cases in which heterogeneous grafts had been used. In sixteen of these a sufficient period after operation had elapsed for recovery to have taken place, but only six of them showed improvement and one, definite recovery of function.

From the experimental standpoint Huber,⁸ Nageotte,¹⁷ Juuanu,¹⁸ Cajal¹⁹ and others have shown that nerve grafts are feasible. The classical experiments of Huber and his co-workers,²⁰ performed under the auspices of the government during the Great War, demonstrated very clearly, at least from the histological point of view, that nerve grafts may result successfully. From the twenty-one series of experiments totaling 279 operations, Huber concluded, "The results of all the experimental work on nerve transplantation indicate clearly, it seems to me, that the most favorable results are to be obtained after the use of auto-nerve transplant and for practical surgery a cable-auto-nerve transplant, using several segments of a cutaneous sensory nerve to bridge a defect in a larger motor-sensory nerve. The question of the type of nerve is not material, the question of the funicular arrangement is of secondary importance, whether the central or distal end of the transplant is placed centrally is not necessary of consideration, accurate and end-to-end suture, careful technic, and dry field, are essential, I believe. As concerns fresh homo-nerve-transplants, I believe I am justified in stating that they serve the purpose of bridging nerve defects quite as well as auto-nerve-transplants, if available, which would very probably not often be the case in practical surgery."

Following the suggestion of Dujarier and Francois²¹ of using nerves stored in sterile vaseline at 2° C and Nageotte's use of 50 per cent alcohol as a storage medium, Huber was able to demonstrate regeneration after both methods. Huber²² also found that non-degenerated heterogeneous nerves were more satisfactory than those that had undergone degeneration, but under no circumstances were they as satisfactory as autogenous or homogeneous nerve transplants. Verga²³ found that a homogeneous or heterogeneous graft from a cadaver always united but later degenerated. According to Ingebrigtsen²⁴ the failure of heterogeneous transplants is due to necrosis of the transplanted portion and the only hope of success lies in the use of autogenous and homogeneous transplants. On the other hand, Juuanu¹⁸ believes that dead grafts are superior to fresh ones and in his experimental studies used 2 per cent formalin as a storage medium.

Although the majority of reports which deal with the results of nerve grafts in experimental work lend support to this type of operation to repair large nerve defects, the attitude of the majority of surgeons in this country and in England is one of doubt as to the ultimate value of nerve transplants. On the other hand, French surgeons are more optimistic and believe that functional results can often be obtained. Depage²⁵ recommended the use of autogenous nerve grafts when end-to-end suture is not possible and Gosset²⁶ and Joyce²⁷ also reported successful results from nerve transplantation. On the contrary, Stopford²⁸ and Platt²⁹ have supplied a detailed report of the failure of functional recovery in thirty instances. Platt and Bristow³⁰ stated that an unbiased study of the results of the various bridging operations showed that there was no justification for their continued inclusion in the repertoire of peripheral nerve surgery, that nerve grafting should be done only as a last resort and that there are only a few instances in which it is justified. Lewis considered that autogenous transplants were superior to homogeneous and heterogeneous grafts but unlike Lexer³¹ and Foerster³² stated that he had never seen any functional results following the use of cable transplants. Stookey³³ and Lewis³⁴ both express the opinion that the development of a dense barrier of scar tissue at the distal suture line of the transplant may act as a barrier to the downgrowing neuraxons. Delangeniere³⁵ stated that the success of nerve transplants diminishes with the increase in the length of the graft. Tinel³⁶ noted the appearance of tingling in distal portions of the extremity following the use of heterogeneous grafts and considered this as evidence of beginning regeneration, but after five or six months even this doubtful sign of regeneration had disappeared. Contrary to the general belief, Bunnell³⁷ has stated that he found evidence of regeneration following autogenous nerve transplants which had occurred almost as rapidly as that following a simple end-to-end suture. This seems rather strange if Cajal's calculations are accepted, that the rate of growth of neuraxons through scar tissue is about one-tenth as fast as through the distal portion of a severed nerve since in nerve transplants neuraxons must pierce two suture lines. Recently, Ballance and Duel³⁸ placed autogenous transplants in the Fallopian canal in lesions of the facial nerve and report returns of functional activity which are so uniformly successful that in view of past experiences one must become skeptical of their standards of estimating recovery. Nerve regeneration must occur from the central segment and the neuraxons must go downward into the distal segment. There is no reason to suppose that this should occur more rapidly in the facial nerve than in any other nerve of the body, and from the evidence produced by a large number of workers it is obvious that if regeneration occurs it must be more doubtful in cases in which transplants are used than in direct end-to-end suture.

The regeneration of neuraxons has been estimated to be about one millimetre a day. Therefore, the time required for them to grow the entire length of a nerve transplant would depend directly upon its length. Even though

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a nerve suture is performed with meticulous attention to detail the rapid growth of connective tissue may afford a barrier which the regenerating nerve fibres cannot penetrate. The additional time necessary for the axons to grow down the length of the transplant, after they have passed the proximal suture line successfully, gives connective tissue an opportunity to form a dense obstruction at the suture line. Thus an otherwise successful nerve transplant may end in failure because neuraxons are unable to penetrate the connective-tissue scar between the distal end of the transplant and the distal end of the divided nerve. A series of experiments were undertaken to determine whether or not resection of this scar-tissue barrier and resuture of the distal end of the transplant and the distal end of the nerve would allow the neuraxons to enter the distal segment of the divided nerve. An exhaustive survey of the literature failed to show that this type of experiment had been performed, although Stookey and Lewis have suggested that such an operation might be feasible.

EXPERIMENTS—The sciatic nerve in a dog was exposed from its entrance into the thigh to the point of its division. A section of the nerve varying from three to seven centimetres in length was removed with a thin, sharp razor blade. This produced a defect in the nerve trunk analogous to those which are encountered in lesions of the peripheral nerves in man in which a loss of substance has occurred. The removed section was then replaced as an autogenous graft. In some experiments, this graft was reversed end for end and in others it was replaced in the same position from which it had been removed. In some, attention was paid to maintain the original topographical funicular anatomy while in others this was disregarded entirely. Fine waxed single strands of untwisted Corticelli triple A silk threaded on fine curved needles were passed through the epineural sheath of both the nerve and the graft. Care was taken to have each suture pass through the sheath about one-sixteenth of an inch back of its edge. An average of eight such sutures were used at the central and distal suture lines. After all of the sutures had been tied the epineural sheath edges were everted slightly to insure good funicular approximation and to obviate a space between the end of the nerve and that of the transplant. In every case the sutures were not introduced until all bleeding had been controlled and the clots washed away with sterile physiological salt solution. The wounds were closed carefully in layers to prevent the presence of cavities in which serum or blood might collect. All of the animals were observed regularly and those which developed severe trophic sores or infections, usually incited by the animals chewing on the insensitive part, were discarded from the study.

Four groups of four animals each were used. In Group I the animals were re-operated upon forty-five days after the introduction of a nerve transplant of the sciatic nerve. The distal suture line scar was resected and the distal end of the transplant and the distal end of the nerve were resutured. In Group II the time interval between the first and second operations was sixty days, in Group III, seventy days, and in Group IV, eighty days. In every instance the type of operation was the same and the time limit only was varied. The nerves from sixteen animals were stained by Ranson's pyridine silver method and comprise the material upon which this report is based. The nerves from sixteen other animals are to be stained by other methods as a separate study. The time limit in all of the experiments was too short to permit a study of the return of functional activity.

GROUP I—Four animals were re-operated upon forty-five days after the nerve transplant. The nerve was carefully inspected for the formation of neuromas and gross signs of the growth of neuraxons in the transplant and the distal segment of the

peripheral nerve. In all there was a fusiform swelling at the proximal suture line and in two in which the grafts were only three centimetres in length there were larger and more bulbous swellings at the distal suture line. In one nerve in which the transplant was six centimetres long there was a very slight swelling at the distal suture line. In another in which the transplant was four centimetres long the neuroma at the distal suture line was approximately the same size and shape as that at the proximal line of suture. In each of the animals the neuroma at the distal line of suture was resected and the distal end of the transplant and the end of the distal segment of the nerve were re-united as in a primary nerve suture. Dogs 1, 3 and 4 were killed forty-five days after the second operation. Dog 2 began to chew its foot on the thirty-fourth day and

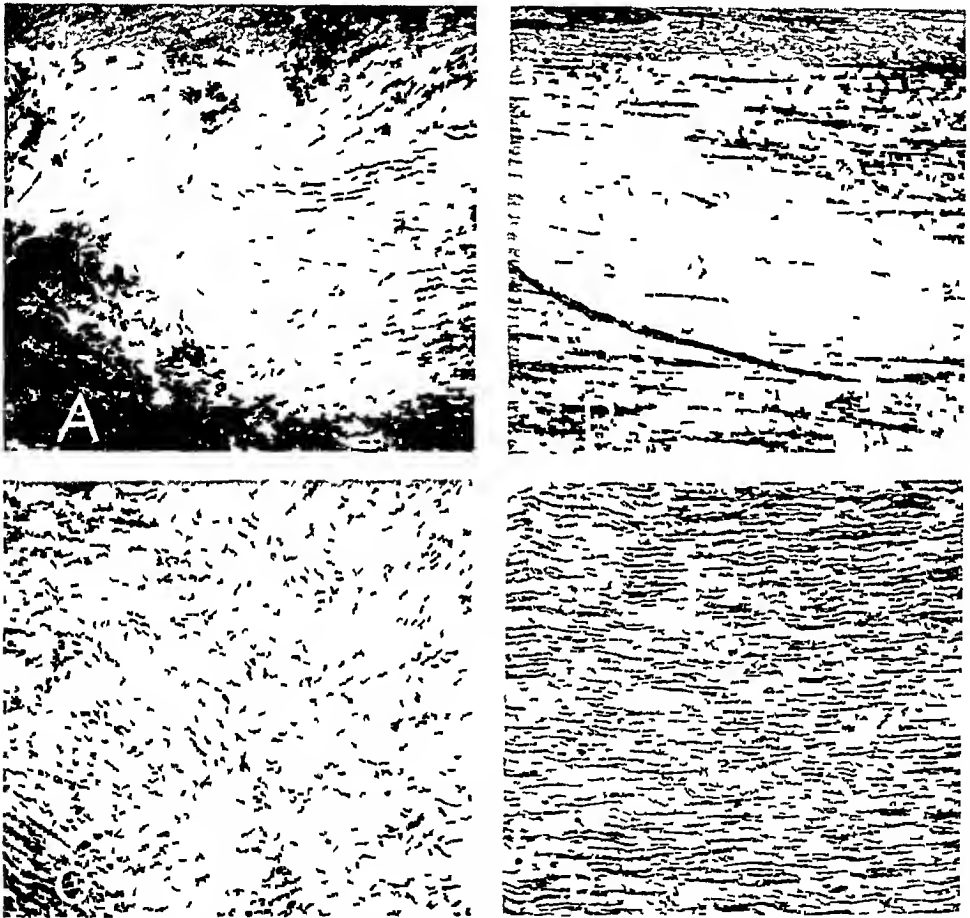


FIG. 1.—Microphotographs of (A), distal suture line forty five days after primary suture, (B), distal nerve segment forty five days after primary suture, (C), distal suture line forty five days after resection and resuture of distal end of the transplant and the distal segment of the nerve, (D), distal nerve segment forty five days after second suture.

was killed to prevent a severe infection. Microscopically, the histological appearances at the central line of suture were similar in all four specimens. That is, axons branched into fine unmyelinated neuraxes in the central end of the sound nerve where many of them ended as spirals or end-bulbs. Many others passed into a mass of connective tissue where they passed through a tortuous course before they again assumed a straighter path to enter the central portion of the transplant. Many of the neuraxes ended in the substance of the transplant but large numbers could be traced through in the serial sections to the end of the graft where branching again became more profuse as the neuraxes either ended or entered the scar tissue at the distal line of suture. The course of these neuraxes through this distal scar tissue was quite similar to that

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seen in the proximal suture line except that more of them ended and fewer reached the distal segment of the peripheral nerve than was the case in the longer transplants. Sections of the neuromas resected at the secondary operation in all cases showed a rather heavy mass of connective tissue. The distal neuroma resected in the shorter transplant contained many intertwining neuraxes, none of which reached the distal segment of the nerve. The distal neuroma removed from the four-centimetre graft contained a very heavy connective tissue but very few neuraxes. The distal neuroma removed from the six-centimetre graft contained very dense connective tissue and no neuraxes. In all of the specimens that part of the distal segment of the peripheral nerve close to the line of suture showed a rather heavy sheath of connective tissue which constricted the

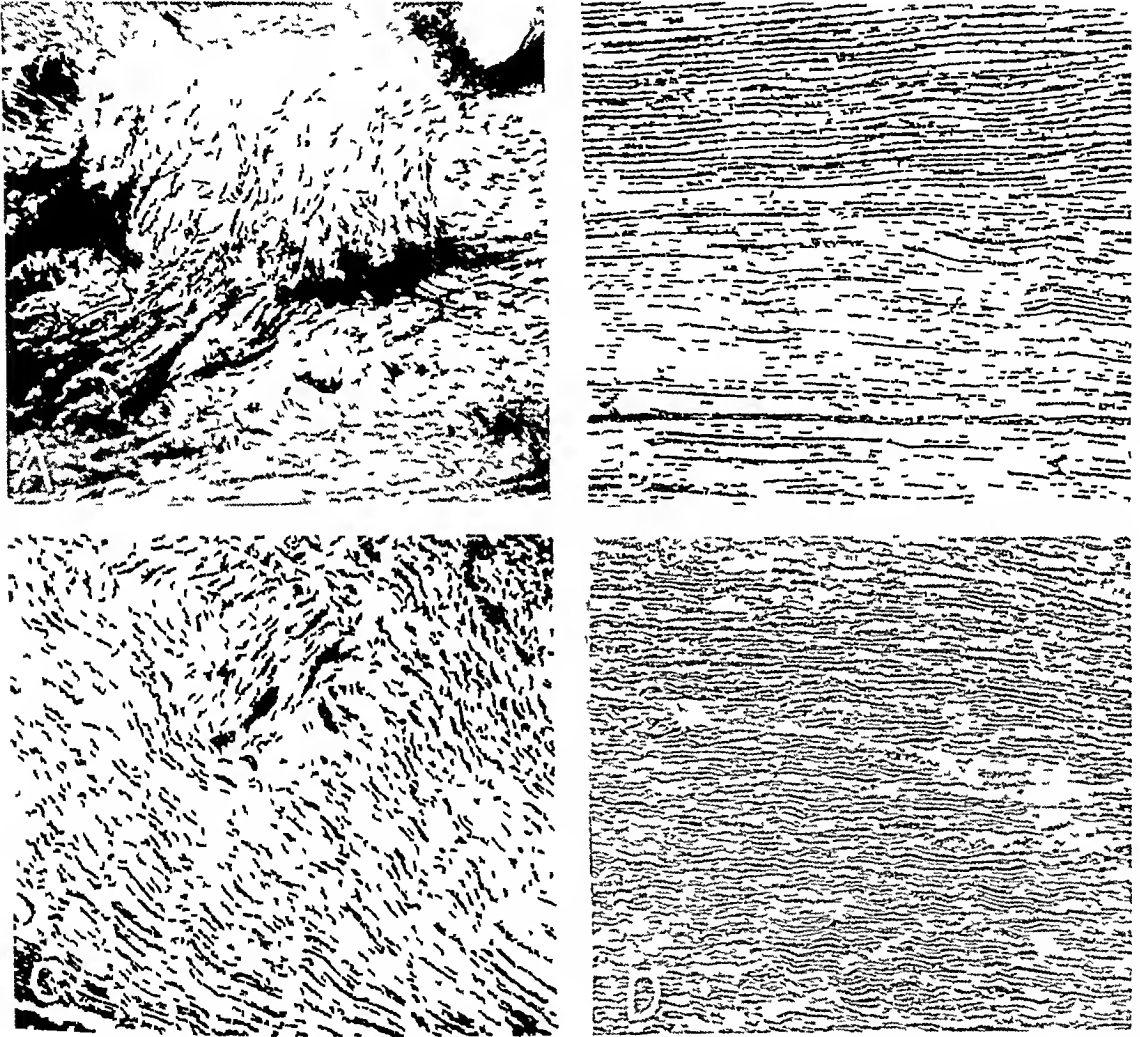


FIG 2—Microphotographs of (A), distal suture line sixty days after primary suture, (B) distal nerve segment sixty days after primary suture, (C) distal suture line sixty days after resection and resuture of distal end of the transplant and the distal segment of the nerve, (D), distal nerve segment sixty days after second suture

potential lumen of the nerve. The thickness of this sheath tapered off to its normal size within a distance of one centimetre from the neuroma (Fig 1)

GROUP II—Dogs 5, 6, 7 and 8 were re-operated upon at the end of sixty days. Fusiform neuromas were found at the central and distal lines of suture in Dogs 5 and 6 in which segments five and six centimetres long were removed and resutured. In Dogs 7 and 8 segments three centimetres in length were removed and resutured. These presented fusiform proximal neuromas and large bulbous distal neuromas. The dogs were killed after a second sixty-day interval and the nerves were removed for study.

Microscopical section of the distal neuromas resected at the second operation showed that in Dogs 5, 6 and 7 there was profuse branching of the fine neuraxons in the distal

end of the transplant. Many of them ended as spirals, or bulbs, and others entered the connective tissue at the distal suture line where they wound in and out in a tortuous pattern. Most of the neuraxes ended in the proximal portion of this connective-tissue mass, but a small percentage of them pierced through to the distal edge. Only a few of these neuraxons entered the distal segment of the nerve. In the neuroma removed from the three-centimetre transplant of Dog 7 the course of the neuraxes through the connective tissue was much straighter than in the other two, and a greater percentage reached the distal segment of the nerve. The neuroma removed from Dog 8 contained only connective tissue and no neuraxes. Both the transplant and the distal segment of the nerve showed evidence of complete degeneration.

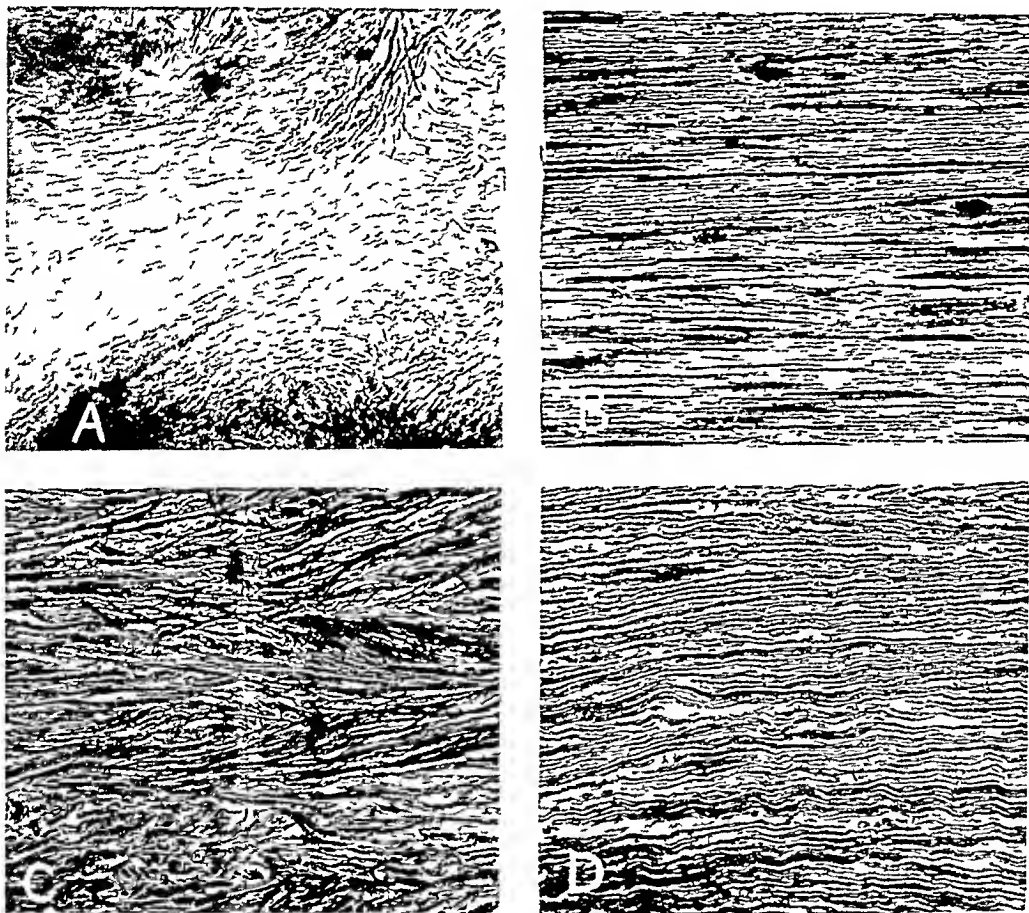


FIG 3—Microphotographs of (A), distal suture line seventy days after primary suture, (B), distal nerve segment seventy days after primary suture, (C), distal suture line seventy days after resection and resuture of distal end of the transplant and the distal segment of the nerve, (D), distal nerve segment seventy days after second suture. Note the large number of axones in the distal segment.

Microscopical sections of the nerve and transplant removed when the dogs were killed sixty days after the second operation revealed in each instance that connective tissue was less predominant at the distal suture line than in the primary distal neuromas, and the course of the neuraxes through this connective tissue was much less tortuous. At the distal line of suture the neuraxes branched in a synaptic manner, after which they again converged and followed a straight course to enter the distal segment of the nerve either in, or along, the protoplasmic bands of the degenerated nerve. The epineural sheath of the distal segment of the nerve was quite thick, and contained a heavy ingrowth of new connective tissue near the suture line, which diminished as the nerve was followed distally. (Fig 2)

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GROUP III—In this series of four animals, resection of the distal suture line neuroma was performed on the seventieth day after the first operation and in each case the distal suture line presented a bulbous swelling whereas the central line of suture was fusiform in shape. Sections of the resected distal neuroma showed that large numbers of fine neuraxons had grown through the transplant both intra- and extra-protoplasmically to reach a dense scar of connective tissue at the distal end. Many of the neuraxes ended in the distal end of the transplant while others gave off branches which entered the scar to take a very winding and tortuous course in the connective-tissue mass. Except in the neuroma removed from Dog 10, most of the fine neuraxons ended in the proximal portion of the scar where they grew in every direction, many of them curling back to-

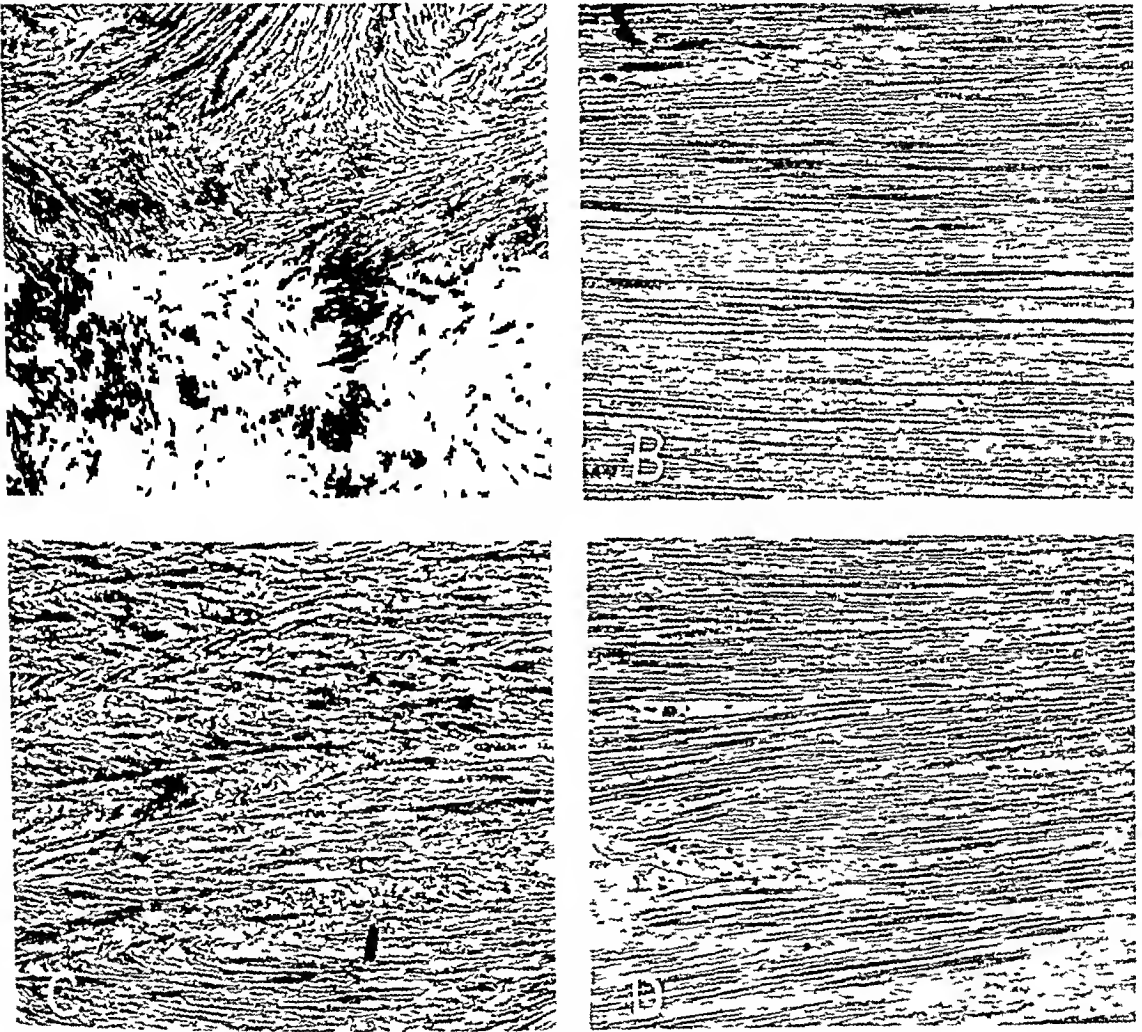


FIG 4—Microphotographs of (A), distal suture line eighty days after primary suture, (B) distal nerve segment eighty days after primary suture, (C), distal suture line eighty days after resection and resuture of distal end of the transplant and the distal segment of the nerve, (D), distal nerve segment eighty days after second suture

ward the central end. The distal segment of the nerve in each case was compressed tightly by connective tissue at the suture line and only a very few neuraxons had succeeded in growing into the distal portion of the nerve. In Dog 10 the transplant was three centimetres in length and a large number of neuraxons had grown entirely through the transplant and distal suture line into the distal segment of the nerve. The neuroma in this case was much smaller than in the other three of this group and the connective tissue less dense.

Sections of the nerve and transplant removed when the dogs were killed seventy days after the secondary operation showed branching of the neuraxes in the distal portion of the transplant before they entered the connective tissue at the secondary distal suture

line Beyond the suture line they converged to enter the distal segment of the nerve in a straight course The number of regenerating nerve fibres was greater than the number of protoplasmic bands representing the degeneration that had preceded (Fig 3)

GROUP IV—Studies of the neuromas resected from the distal suture line eighty days after the introduction of the transplant in Dogs 13, 14, 15 and 16 showed that in each case the transplants had been entirely traversed by regenerating nerve fibres In Dog 15 the transplant was three centimetres in length and the neuraxons had pierced the distal suture line and many had grown into the distal segment of the nerve In the other three animals the majority of the neuraxes ended in the scar formed at the distal suture line and did not enter the distal segment of the nerve The most central part of the distal segment of the nerve in each case was somewhat constricted by connective tissue and degeneration within the nerve was complete

The sections of the nerve and transplant which were removed when the dogs were killed eighty days after the resection of the distal neuromas showed branching of the neuraxes in a fork-like manner as they entered the relatively small amount of connective tissue at the distal suture line Their course became straighter and large numbers either entered or followed the protoplasmic bands in the degenerated portion of the distal segment of the nerve where they could be followed to the end of the sections (Fig 4)

Comment—We believe that these experiments show that the scar tissue formed between the distal end of the transplant and the end of the distal segment of the nerve during the time of growth of the neuraxons through the transplant may be a barrier through which the new nerve fibres cannot pass We also believe that these experiments show very definitely that resection of this neuromatous barrier and resuture of the distal end of the transplant to the end of the distal segment of the nerve will permit continued downgrowth of the neuraxons into the distal segment of the nerve

The clinical results obtained by surgeons in cases in which nerve transplants have been used and the experimental results of many investigators have been at variance Perhaps one of the factors which has contributed to this difference in conclusions is the fact that experimental conclusions have been based mainly upon microscopical studies alone Another factor which must be considered is the difference in the length of the transplant On the ordinary laboratory animal only relatively short transplants can be used, whereas in humans it is in the large defects of nerve substance in which end-to-end suture is not possible that the surgeon resorts to the use of transplants That the length of the graft plays an important part is borne out by our results, which were obtained in Dogs 14 and 15 In the first, a seven-centimetre section had been removed and a very solid scar had formed at the distal suture line In the latter, a 3 three-centimetre transplant had been traversed by many neuraxons before a sufficient amount of connective tissue had grown at the distal suture line to block their further progress It is obvious that sufficient time should elapse between nerve transplantation and the resection of the distal neuroma for the downgrowing neuraxons to reach the distal suture line It is our observation that at least seventy days should elapse in a three-centimetre graft and, of course, in longer grafts a correspondingly longer time

Although the number of cases are few, in which a nerve transplant is the only possible method of affording a chance of recovery of function, nevertheless large destructive wounds are encountered in civil life. It becomes a problem not only to find a nerve which can be sacrificed in sufficient length for use as a transplant without irreparable harm to the patient but to use a nerve the calibre of which is equal to that of the injured nerve. The latter naturally presents the greatest difficulty.

We have not as yet had occasion to do so, but it should be possible to use a homogeneous graft of the same nerve obtained under sterile conditions from a fresh autopsy specimen. That a nerve transplant operation is not an emergency procedure makes this possible step a practical one. Our own few experiments with homogeneous grafts have been followed by histological results exactly similar to those we have obtained with autogenous grafts. Moreover, Huber's studies mentioned previously provide a sufficient basis for undertaking such a procedure. Certainly, the clinical results obtained with autogenous cable grafts have been so disappointing as to discourage further attempts to make practical use of them. Finally, nerve transplants have not been performed in any considerable number of cases under the ideal surgical conditions which are possible in civil life.

A careful examination of a large number of cases in which nerve transplants have been performed is necessary before any final conclusions can be reached as to the efficiency of this procedure. As has been stated before, in general, nerve transplants have not been followed by the degree of regeneration and functional recovery which we might have believed would occur as the result of animal experiments. The conditions under which many nerve transplants are performed, the lack of co-ordination between neurologist and surgeon, as well as the impossibility of re-examination over a long period of time serve to make many of the statistics in the literature valueless. Many of the available statistics were based upon the observations of individuals other than the surgeons who operated upon the patient. Not only is this true but often re-examinations have not been conducted over long periods of time by the same observer and recourse was had to questionnaires. That such conditions might lead to a divergence of opinion as to the value of nerve transplants might well be expected. The same criteria of a successful result must be employed even more critically in judging the results of nerve transplants than in the examination of functional recovery following end-to-end suture. For example the return of a patient to work certainly cannot be used as an index of recovery and regeneration of nerve lesions in which supplementary motility is not carefully excluded.

¹Since submitting this manuscript for publication, we have had an opportunity to use this method in the case of a patient who suffered an injury to the tibial nerve with a loss of substance. A four inch homogeneous graft of a sciatic nerve removed from a freshly amputated extremity was used. At the second operation, the graft was found to be in good condition. Sufficient time has not elapsed as yet to judge of the clinical results.

Further, it must be well recognized that the early return of protopathic sensibility in certain areas, or the shrinkage of analgesia may be due only to the assumption of function of adjacent uninjured nerves. Likewise, changes in the color or nutrition of the skin alone are valueless as indications of recovery of function.

CONCLUSIONS

(1) In nerve transplants the scar formed at the line of suture between the distal end of a transplant and the end of the distal segment of the peripheral nerve may act as an impenetrable barrier to the downgrowing neuraxons.

(2) Resection of this distal scar and resuture of the distal end of the transplant and the end of the distal segment of the peripheral nerve may allow continuation of the growth of the neuraxons into the distal segment of the nerve.

(3) Neuraxons may grow through a nerve transplant three centimetres in length to reach the distal line of suture at the end of sixty to seventy days.

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FURTHER EXPERIENCE IN THE RELIEF OF PAIN BY SECTION OF THE RAMI COMMUNICANTES AND GANGLIONATED SYMPATHETIC CORD

By FRANCIS A C SCRIMGER, M D , F R C S (C)
OF MONTREAL, CANADA

IN 1929, I presented before the surgical section of the New York Academy of Medicine a paper based on the behavior of two patients suffering from abdominal pain in whom no gross abdominal disease could be demonstrated. The pain associated, with typical hyperæsthetic zones of the Head type, was in each instance relieved by section of the sympathetic rami communicantes at the appropriate levels. To these I add two other cases recently observed and operated upon together with a report on the subsequent history of the earlier cases.

It is surprising to realize how little interest, comparatively speaking, is taken by the average surgeon largely concerned with abdominal disease in the accurate understanding of pain perception in visceral disease or in the visualization of the afferent paths from the sympathetic by which pain must be perceived. More particularly for a rationalized treatment, a knowledge of the pain paths is much to be desired in patients suffering visceral pain where no gross disease can be demonstrated or when the disease is of such a nature that the removal of the cause of pain is not possible.

In an earlier paper I pointed out, as is well known, that the acuteness of perception and pain varies greatly with the individual and varies in the same individual under different circumstances of health and more especially of attention.

It will not be surprising to find that in most instances the patients showing these signs and suffering these pains are of the hypersensitive type and have concentrated on their disease, that they do so should not shut them out from our sympathy. It is difficult to compress into reasonable space the diverging and contradictory views held regarding the perception of pain, and its by-product, referred pain, but no small part of the interest of these two case reports rests on the evidence they furnish of the paths of pain through the sympathetic into the spinal columns. We have, perhaps, thought of the autonomic nervous system as more apart from and different from the cerebrospinal than is the case. This has, I think, hampered our understanding and made us slow to realize that the method of perception of afferent impulses from the viscera is not essentially different from our perception of afferent impulses through the somatic nerves. It is true that the stimuli setting up these impulses are somewhat different and that where the usual surface pain stimuli are pinching or cutting, the stimuli to which the autonomic system is sensitive are hypercontraction or distention.

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If we look to its origin Remak, in 1847, and Balfour, in 1877 pointed out that the autonomic is derived from the cerebrospinal. The investigation of Anodi, His and Marshall added further evidence and Froniep, in 1907, demonstrated that cells of spinal origin advanced along the ventral roots and entered the primordia of the sympathetic trunks. Kuntz beginning in 1909 showed first that the autonomic ganglia held the same relationship to the cerebrospinal nervous system in all vertebrates and that they arise from cells of cerebrospinal origin, which are displaced peripherally along the dorsal and ventral roots of the spinal nerves. Some of the cells of the same origin advance beyond the primordia of the sympathetic trunks and give rise to the pre-vertebral sympathetic plexuses. Kuntz further states that as early as fibres can be observed in the communicating rami, they are accompanied by cells identical with those in the sympathetic primordia. These cells are of the same character as are present in the spinal-nerve trunks and the majority of those which deviate from nerve trunks along the paths of the rami enter the sympathetic primordia. Ganfinni has also described the communicating rami in early mammalian embryos as a cellular structure. In origin therefore, the sympathetic is not different from the somatic.

It is not necessary to describe the various divisions of the sympathetic but certain characteristics stand out. The anatomical arrangement of the afferent supply of the viscera is not basically different from that which obtains in the skin. The cell body of the afferent neuron lies in a dorsal root ganglion. Its peripheral process runs to the structure innervated, its proximal to the neuraxis. The efferent fibres with only two known exceptions the carotid body and the carotid sinus, consist of pre- and post-ganglionic fibres. The pre-ganglionic fibres of the efferent system have their cell bodies in a column of cells in the lateral horn. The fibres make their exit from the cord in company with the somatic fibres of the ventral root. They then leave the ventral root turn forward, and enter a sympathetic ganglion. Such a nerve trunk is called a white ramus, but the white ramus carries also afferent fibres which enter the cord by the dorsal roots and connect with probably the normal pain columns of the cord.

From the ganglionated cord in addition to other branches come fibres which join the spinal nerves for the innervation of the visceral structures in the domain of that nerve. Such a branch is non-medullated and is the gray ramus. There is great divergence of opinion as to whether the afferent pain paths pass to the cord wholly by the posterior roots, or, as claimed by Lehman Foerster and others also by the anterior roots. This is an important point. If pain conduction is wholly by the posterior root, it is possible to interrupt this path completely and in appropriate cases to control pain by cutting a sufficient number of dorsal roots. If, further, the visceral pain paths reach the posterior root wholly through the white rami, it should be possible to control painful sensations by cutting these rami, provided sufficiently accurate formation can be found to localize the point of stimulus. It is in this connection that the cases here reported are of interest.

The question whether pain conduction is wholly by the dorsal roots is ably discussed in a recent paper by Davis, who feels forced to the conclusion that if sufficient dorsal roots are cut, all sensation, superficial and deep, all afferent impulses, somatic and sympathetic, are abolished. The apparently contradictory evidence may be explained by a far wider occurrence of overlap than is generally conceded, such, for instance, as occurred in a patient operated upon recently by Doctor Cone. The 1-6 dorsal roots were severed on the left side with a corresponding anaesthesia, disappearance of pain, and heat changes with sweating. At the same time the first dorsal root on the right side was cut and on subsequent examination no evidence of the section of this root could be made out. The knowledge of overlap is, of course, not new but the extent of it is not always taken into account.

Similarly, it should be possible to sever the afferent sympathetic paths if they can be shown to pass in wholly by the white rami, but it is well recognized that the afferent paths from an abdominal viscera may pass in by any one of several rami or even by several rami. It is here that the location of the referred pain may be useful. It has been taken that the referred pain in the skin, the Head zone, which has been held as a necessary symptom, does indicate the level of the sympathetic irritation on the supposition that the area of hyperaesthesia in the skin to normal stimuli represents an inflowing sympathetic irritation of corresponding level, making the dorsal pain column so irritable that normal skin contact is perceived as pain. This pain may theoretically be blocked by interrupting the somatic nerve, to cut off the normal stimulus to the skin, which is perceived as pain, or by interrupting the afferent paths of the sympathetic which on this hypothesis is causing the dorsal pain columns to be hypersensitive. Ross MacKenzie and Head all subscribe to the view that visceral disease sets up a focus of irritability in the cord and sensory impulses passing into this are exaggerated into pain.

I shall not detail the histories of the two earlier cases, their interest lies at present in the fact that in both the pain was relieved by severing the white rami alone. In the first, operated upon in 1926, the tenth, eleventh, twelfth and first lumbar were cut and her pain was entirely relieved at the time. Since then she has had various distresses, she has had two subsequent operations, one for the removal of the uterus and the other a removal of the gall-bladder, but what she designates as "the old pain" has not recurred. She has been able to do her work and live a normal life. There is no hypersensitive area. The second case, operated upon in 1927, had a section of the rami from the ninth, tenth, eleventh and twelfth dorsal, had had some return of pain from time to time up to 1929. She was recalled in 1932 for examination, she has been able to do her housework, has not had any return of pain for nearly a year and there is no area of hyperaesthesia.

In the cases here reported, both complained of pain, one on the right side and one on the left. The right-sided pain had been present with varying, but increasing, severity for eight years. It was referred to the right side of the abdomen and back. It was associated with an area of hyper-

æsthesia in the distribution of the tenth and eleventh dorsal nerves. The hyperæsthesia was markedly definite in outline—it stopped abruptly at the mid-line. Nupercaine was injected opposite the tenth intervertebral foramen but forward on the bodies of the vertebrae so as to catch the sympathetic ganglionated cord but not the intercostal nerve. This resulted in two interesting observations. For a period of six hours the pain disappeared—the area of hyperæsthesia disappeared but normal sensation was maintained over the hyperæsthetic area. One must conclude that the blocking of the sympathetic resulted in the relief of the pain. That the sympathetic was blocked was indicated by the disappearance of the goose-flesh pilonidal phenomena over the area, which had been hyperæsthetic. That is, the efferent paths, the gray ramus, from the ganglionated cord to the somatic ramus was blocked. There were no changes in superficial heat as tested by the thermocouple.

During the operation the white rami were displayed passing to the ninth, tenth, eleventh and twelfth dorsal roots. This led to the ganglionated cord. The cord was severed below the eleventh and above the tenth. The ramus to the twelfth was cut, as also the ninth. Stimulation of the ganglionated cord now produced the goose-flesh appearance and a slight reddening of the skin in the corresponding skin areas. The ganglionated cord and at least two ganglia were removed in addition to cutting the rami from the ninth to twelfth segments. The pain did not return nor has it up to the present. The area of hyperæsthesia disappeared. The patient did complain of a good deal of pain and soreness in the back, much more than when the rami alone were cut. This was thought to be due to the removal of the posterior ends of the ribs.

The patient with the pain on the left side was a young, highly emotional woman. The distribution of the pain was in the left abdomen and in the back on the left side. The hyperæsthesia was extreme, so that even a motion towards the area resulted in a shinking away. The relief from nupercaine was of a shorter duration but associated with the same disappearance of the hyperæsthesia and retention of normal sensibility. There was here also disappearance of the pilonidal reflex but no heat change. It can, I believe, be said that in these two instances also, abdominal pain together with an area of hyperæsthesia has been relieved by interruption of the sympathetic afferent paths.

The case reports are as follows

CASE I—Miss G. First admission, May 13, 1931. Pain in back and twitching on left side. Pain when she lies on her right side. The main complaint is pain in the left side into the groin and across the lower abdomen. This started March 1. It was at first a twitching of the muscles. She had some nocturia and trembled under any emotional strain. There is a history, three years earlier, of sharp pain suggesting renal calculus. Examination at this time revealed no definite disease. *Diagnosis*—Neuralgia. Blood chemistry normal. Heart and lungs normal. Gall-bladder normal. X-ray of intestinal tract showed colonic stasis. Genito-urinary tract normal.

Re-admitted December 14, 1932. Since discharge she has had the same pain in the left side of the abdomen and back, becoming worse. Said to have had blood in

the urine on occasions. Tenderness in left side of abdomen and pain—otherwise as before—all examinations repeated. Pyelogram shows a slightly dilated renal pelvis. January 9, 1933, the patient was seen by Doctor Scrimger, who noted an area of hyperæsthesia in the distribution of the eleventh dorsal nerve. Consultation with the Orthopaedic Service, Doctor Turner, found no disease of the spine or sacro-iliac joints.

January 18, 1933, seen by Doctor Cone of the Neurological Surgical Department, who confirmed the area of hyperæsthesia. Thirty cubic centimetres 1/1500 nupercaine were injected below the ninth rib, the pain diminished but the hyperæsthesia area remained. Twenty cubic centimetres were injected against the body of the vertebra, a segment lower, and the area of hyperæsthesia disappeared and the pain was relieved. Normal sensation remained. Temperature tests of skin with thermocouple revealed no notable change. Goose-flesh reaction could be brought out down to but not over the area which had been hyperæsthetic. The relief of pain and loss of hyperæsthesia lasted only three to four hours. Pain then returned as before. January 31, 1933, area of hyperæsthesia marked out and photographed.

Operation—Sympathetic ganglionectomy. Incision over vertebral spines from ninth to twelfth dorsal. The muscles were pushed to the lateral side until the transverse processes were exposed. The transverse processes of the tenth and eleventh vertebrae were chiseled off close to the body of the vertebra. The tenth and eleventh ribs were then cleared and removed from about one and a half inches of the medial end up to the articulation with the vertebrae. The intercostal nerves of the ninth, tenth and eleventh were dissected free and the white rami communicantes isolated. The dissection was then carried forward over the body of the vertebra until the ganglionated cord was exposed, into which the white ramus of each segment could be seen entering. The sympathetic cord was then cut below the ganglion corresponding to the eleventh and below the ganglion corresponding to the ninth. The white ramus was in each case cut but the communication to the ganglion corresponding to the tenth and the eleventh was left intact.

At this point electrical stimulation of the nerve of the ganglionated cord was made, with a current sufficiently strong to produce a definite muscular reaction. On the left side of the abdomen corresponding to the area of hyperæsthesia there was observed during the stimulation a goose-flesh phenomenon and a slight change of color towards hyperæmia. The changes were not very marked but were considered to be present. The ganglionated cord was then removed. The portion removed included the ganglia corresponding to the eleventh and tenth with a portion of the cord above and below and the white rami of the ninth, tenth, eleventh and twelfth. The wound was then closed.

Following the operation the area of hyperæsthesia disappeared and the pain in the abdomen was relieved. She complained of a great deal of pain in the back on respiration but gradually this subsided. The objective evidence of hyperæsthesia and goose-flesh phenomenon have remained absent to the present date. She is relieved of pain in the abdomen but still complains of pain in the back.

CASE II—Mrs R Ch, forty-three. History of pain dating back for eight years. The onset was with pain in the region of the right kidney. She was told that the right kidney was enlarged and some operation on the urethra was performed. She was then free from pain for nearly four years, when she received an injury and the right side was swollen and bruised. The pain in the kidney region returned and a diagnosis of pelvic infection was made. This subsided after some months but the pain in the right kidney returned, accompanied by some frequency. There was here also a history, not supported by observation, of some blood in the urine.

The pain has continued and she has been unable to wear her clothing or do her work. Except for the pain and tenderness on the right side of the abdomen, the ordinary examination revealed nothing abnormal. Special examination proved a normal urine and kidney. Specialist's examination of pelvis was reported normal. Barium meal and enema showed no disease. On examination of the abdomen an area of local-

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ized hyperæsthesia was found corresponding to the pain. As in the previous case an injection of nupercaine to block the sympathetic ganglionated chain resulted in the disappearance of the hyperæsthetic area and relief of pain for seven hours without loss of normal sensation over the previously hyperæsthetic area.

February 10, 1933, a ganglionectomy with ramisection was performed. The steps for the operation were exactly as in the previous case. The transverse processes of the tenth, eleventh and twelfth vertebræ were removed together with the posterior one and a half inches of the corresponding ribs. The white ramus of the ninth, tenth, eleventh and twelfth segments was isolated and traced forward to the ganglionated cord. The cord was cut below the eleventh and below the ninth, these rami being still intact. Stimulation by faradic current of the cord resulted in a definite goose-flesh phenomenon in the previously hyperæsthetic area and a slight reddening of the skin. The rami of the ninth, tenth, eleventh and twelfth were severed and at least two ganglia removed, the tenth and eleventh. As before the hyperæsthetic area became normally sensitive and the pain was relieved.

As before, a good deal of pain was complained of in the region of the wound. The pain and hyperæsthesia have not returned at the time of reporting.

SYPHILIS OF THE CLAVICLE

BY FRANCIS M CONWAY, M D

OF NEW YORK, N Y

FROM THE SURGICAL SERVICE OF THE HARLEM HOSPITAL, DR JOHN F CONNORS, DIRECTOR

THE presentation of this subject from the Surgical Service of the Harlem Hospital was stimulated by the occurrence of three cases of luetic involvement of the clavicle which were admitted to the service following minor injuries to that part. On our service many fractures of the clavicle come under observation. The unusual character of the radiographs of these cases and the response to specific therapy were so pronounced that a review of the lesion was considered timely.

In an age when syphilis receives careful attention, where the Wassermann reaction is employed routinely and where specific therapy is readily instituted, the incidence of gummata of bones is rapidly diminishing. These facts, combined with the observation that luetic involvement of the body of the clavicle is in itself an uncommon finding, make its existence even more unusual. In this discussion, we are not concerned with the luetic involvement of the sternoclavicular articulation which has been seen with sufficient frequency to warrant a suspicion as to the diagnosis by inspection. The cases which are herein described are those which involve the corpus of the clavicle. In the first case, we have the type referred to as the osteoperiosteal type, the radiograph of which has frequently been mistaken for an early Paget's disease, a bone sarcoma or a secondary bony metastatic deposit (Fig 1). The second and third cases are of interest to the traumatic surgeon because of the fracture occurring in the bone previously damaged as the result of syphilitic involvement (Figs 4 and 5).

Etiology and Pathogenesis—With the tibia, the radius, sternum and frontal plate of the skull, the clavicle is one of the sites of predilection of bone syphilis. This fact is easy to understand when one takes into account the effect of trauma on patients of luetic diathesis. The clavicle is, in fact, one of the bones where fracture, either spontaneous or traumatic, is easily facilitated. Its shape as an italicized "S" exposes it, as we know, to direct violence and at the same time being fixed between sternum and shoulder girdle it is at the mercy of traumata which may be received on the upper extremity. Therefore, the bone, by virtue of its position, form and superficiality, is exposed without any muscular protection to all forms of external violence. Hunter, Virchow and Cornil demonstrated that minor traumata are sufficient to call forth luetic bony manifestations at points of contact

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As regards its incidence, Jullien, in sixty-four cases of gummata of bone, reported the following

Nose	19	Os frontale	1
Tibia	15	Os parietal	1
Palate	15	Vertebræ	1
Sternum	5	Scapula	1
Clavicle	4	Patella	1
Maxilla	4	Bones of forearm	1

There are three distinctive stages which may present themselves with osseous syphilis (1) Simple osteoperiostitis, (2) osteoperiostitis and



FIG 1—(CASE I) Syphilitic involvement of the left clavicle of the osteoperiosteal type showing at (a) the typical vacuolization in an area of gummatous osteomyelitis. The middle portion of the corpus of the clavicle shows a moth eaten appearance with destruction of the normal contour of the bone and at the points marked (b) and (c) there are definite exostoses. Radiograph shows many of the characteristics of both tuberculosis of the clavicle and sarcoma of the clavicle, from which a differential diagnosis must be made.

gummatous osteomyelitis, (3) hyperostotic form of lues. As corollaries of these states we have exostoses, necrosis, and spontaneous fractures.

The causes and the mode of production of these spontaneous fractures present a real interest. Under the title of spontaneous fracture is meant all fractures which occur as the result of a morbid alteration in the bone.

itself which follows a slight trauma quite insufficient to injure a healthy bone

(1) *Periostitis and Osteoperiostitis*—The periostitis is caused by a true primary vascular change. This swelling interferes with the bone causing the characteristic pain. The osteoperiostitis is an extension of the disease into the Haversian canals. These inflammatory processes may end by resolution, especially under treatment, or they may progress to a rarefying osteitis or a proliferating osteitis (Fig 1), the latter causing an eburnation or formation of osteophytes or exostoses. The rarefying osteitis progresses by destroying the walls of the Haversian canals and produces a spongy condition of the bone which may or may not be filled up by bone proliferation. Should bone proliferation not occur, then necrosis results and we come to the stage of gummata.

(2) *Gumma*—Gumma, which is the typical lesion of the tertiary luetic state, is the end-result of the proliferative stages of the inflammatory period. These may be periosteal, subperiosteal, osseous or osteomyelitic.

(3) *Hyperostotic Form of Lues*—The third group of cases referred to as the hyperostotic form of bone syphilis was quite completely described by Hahn and Deycke²⁵ in their presentation of the manifold radiographical peculiarities of delayed congenital and acquired syphilis. Anatomically and radiologically, the purely osteoplastic bone lesions form a particular and characteristic group. They occur either as circumscribed tophi or as diffuse hyperostoses of the long bones. This form is less common than the gummatous form and may occur both in delayed congenital or acquired syphilis. In contrast to the gummatous form, the soft parts are *not* involved in the diffuse hyperostotic type of bone lues.

In an enumeration of these three groups of luetic involvement it must be understood that they are not quite distinct and separate entities. They are different stages of the same pathological condition and perhaps might better be regarded as demonstrating the "proliferative" and "degenerative" phases of one process. The "proliferative stage" or "periostitis" is the precursor of the "degenerative" type. There may often be seen evidence of the evolution of such a process in different bones of the same individual, and when intensive treatment is administered the lesion becomes retrograde in appearance (*viz*, Case I, plate 2 *vs* 1) with the degenerative bone increasing in density and returning to the proliferative stage or periostitis. In the visualization of bone lues various processes are often coexistent but the order of evolution is in a general manner the same.

Laporte,¹² in his Thesis, gives the following review of cases of spontaneous fractures which he was able to obtain from the literature—all of which resulted from trivial injuries.

Symptomatology—There are two never-failing signs of bone involvement, namely pain and tumefaction. The symptom of pain varies but often may be intense and lancinating. It is usually more pronounced at night. The more superficial the bone the more apt is tumefaction to be found. With our cases pain and swelling were pronounced. In the first case (S. M.)

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AUTHORS OF THE CLAVICLE CASE REPORTS		Sex	Age	Clavicle	Site	Immediate Cause	Treatment	Result
Walthers	(1820)	F	46 yrs	Left	Body	Turned in bed	Mercury	Pseudo-arthritis
Delpach	(1823)	M	Adult	Left	Body	Put on vest		Rapid improvement
Rumaud	(1830)	M	Adult	Left	Body	Raised arm		Pseudo-arthritis
Santuchio	(1840)	M	60 yrs	Left	Body	Mounted horse		Pseudo-arthritis
Venot	(1847)	M	28 yrs	Left	Body	Put on coat		Pseudo-arthritis
Chassagnac	(1854)	F	40 yrs	Right	?	Lifted pump handle		Pseudo-arthritis
Gessler	(1862)	F	40 yrs	Right	?	Folded arms		Pseudo-arthritis
Delens	(1875)	F	40 yrs	Right	?	Raised table		Pseudo-arthritis
Patey	(1878)	M	43 yrs	Right	?	Raised cover of bed		Pseudo-arthritis
Dreschfeld	(1881)	F	36 yrs	Right	Body	?		Pseudo-arthritis
Berkeley Hill	(1881)	M	6 wks	Right	Body	?		Pseudo-arthritis
Bouilly	(1881)	F	34 yrs	Right	Body	?		Pseudo-arthritis
Breda	(1884)	F	57 yrs	Left	Body	?		Pseudo-arthritis
Kirmisson	(1889)	M	44 yrs	Left	Body	?		Pseudo-arthritis
Subjects	7 female, 6 male, 1 child		10 body, 2 sternal, 2 unknown					

the swelling appeared without any history of definite trauma and the pain in the clavicular swelling was not especially noteworthy for its intensity

Osteoperiostitis of the clavicle may appear in a very precocious manner and its onset may be characterized by nothing more than vague pains and a slight clavicular puffiness without any localized swelling. The site of the lesion, in order of its frequency, is said to be most frequent along the anterior border or superior face of the body and less frequent at the acromial end of the bone.

The swelling itself may be large or small but is generally fusiform in outline and with its axis in the direction of the clavicle. Suppuration, when it occurs, is usually only slight in amount. With our second case, the immediate trauma was nothing more than an attempt to forcibly open a closed door. This slight exertion produced a fracture and the condition of the previously diseased clavicle may be seen in Fig 4.

Diagnosis—Four factors are preeminent in the establishing of the diagnosis, and they are (1) history, (2) radiograph, (3) serological reaction, and (4) response to specific therapy.

By history is indicated not only the history of initial infection where possible to elicit this, but the absence of any unusual trauma or accident to the clavicle. Suspicion of clavicular lues is always aroused when a painless swelling of the clavicle is noted without any noteworthy trauma.

The radiograph has proven invaluable in the diagnosis, not only because of early recognition but also because of its demonstrating the repair processes occurring after the institution of specific therapy. A myriad of diverse roentgenological findings occur dependent entirely upon the stage of evolution of the process.

Two pertinent and outstanding facts should be noted, first, lues of bone is usually a constructive osteoplastic process and though we have observed various exceptions to this general statement, in the main it is true. Secondly, the extent of the recorded roentgen involvement in lues of bone is rarely paralleled by the clinical symptoms, the clinical findings not being as extensive as the radiographical evidences. This is not the fault of the clinician but the character of the disease.

Distribution may be localized in any part of the bone or diffuse throughout the bone. The first changes are more frequently apparent on the surface of the bone as a fuzzy proliferation of the periosteum, though occasionally the first evidence is a central opacity.

The periosteum may be arranged in strata with definite spacing between each layer. "Bone blisters" may occur with proliferation and elevation of the periosteum over a small area, coexistent with a destructive process, which may break through the periosteum, forming an umbilicated cavity in the cortex.

There may be a proliferation of the periosteum in the form of fine bone trabeculae anastomosing and forming the so-called "lace work." The entire bone may be enlarged with massive increase in the size of the cortex and

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gradual encroachment upon or obliteration of the medulla. The process may be intensified on one surface, giving the appearance of bowing of the entire bone. With the degenerative phase, a massive enlargement of the bone is noted with areas of increased opacity alternating with areas of destruction, but not atrophy. The densely hypertrophied periosteum is gradually encroached upon and destroyed by the degenerative process. In spongy bone, the destructive process is characterized by areas of increased opacity,



FIG 2—(CASE I) Radiograph taken six months after institution of vigorous antiluetic treatment. The entire character of the process in the bone has changed and the normal contour of the clavicle is returning. At the point (a) there still remains a small vestige of the gummatous process seen in FIG 1. At the point (b) periosteal thickening may now be detected indicating the retrograde character of the disease in returning from the destructive to the proliferative phase. At the point marked (c) the bone has practically returned to its normal size.

obliteration of normal trabeculations and, on breaking through the surface, by the appearance of nodular masses. Atrophic changes do not occur as there is usually only slight impairment of function. This fact is in contrast with other bony affections where atrophy of adjunct parts results from disuse. Pathological fractures occur after extensive destruction and never in the early or proliferative stage, when the bone is even stronger than normally. The serological reaction which is invariably positive and the rapid anchora-

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tion of clinical symptoms following a course of antiluetic therapy are probably the most positive diagnostic features

Radiographically, the changes are striking within a short period after the institution of treatment Figure 1, which is the first radiograph of Case I (S M) shows the marked destruction of the corpus of the clavicle and Fig 2 demonstrates the return to practically the normal contour of the bone With regard to the question of differential diagnosis, the desirability of



FIG 3 —(CASE I) The clavicle, taken seven months after the institution of antiluetic treatment, shows a diminution in the amount of periosteal involvement and a further return to the normal outline of the clavicle

making repeated roentgenograms of the clavicle should not be overlooked to determine the effect of diagnostic therapy The reaction of bone lues to proper therapy is usually rapid and as contrasted with tuberculosis of bone—this is striking Sarcoma of the clavicle may be ruled out on this basis as well From confusion with Paget's disease of the clavicle, which may pre-

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sent many identical features of the hyperostotic form of osseous lues, the above-mentioned data are invaluable aids

Treatment—The routine of specific treatment of these cases will vary in different clinics and depend entirely on the preference of the individual treating them. The cases treated by mercurial inunction and intra-oral mercurials in France in the early nineteenth century were all reported as having been benefited by this method. We have given intravenous neoarsphenamine Gm 0.45 at weekly intervals for eight weeks and this followed by weekly bismuth for ten weeks. The result of this régime was quite satisfactory, as may be seen in the radiographical plates as well as in the reported amelioration of the patient's symptoms.

CASE REPORTS

CASE I—S. M., an adult colored woman of fifty, was admitted to the Surgical Service of the Harlem Hospital, April 6, 1932, with the complaint of an increasingly painful enlargement in the central portion of the left clavicle of ten days' duration. There was no history of injury and the patient had no recollection of having been struck in that region at any time. Physical examination disclosed a swelling of the left clavicle in the midcorpus about the size of a small lemon which was hard, tender, but was not warm to the touch. There was no indication of any inflammatory reaction involving the clavicle. Her past history was negative. Radiograph of the left clavicle (April 6, 1932) shows a most unusual appearance. The entire clavicle is the site of a morbid process which seems more advanced in the midcorpus. There are productive and destructive changes with some osteophytic formation (Fig. 1).

Blood Wassermann 4 plus

Diagnosis—Luetic destructive process of left clavicle. Specific therapy was instituted May 5, 1932, as follows:

<i>Neo 0.45</i>	<i>Bismuth</i>
1 5/ 5/32	1 7/13/32
2 5/12/32	2 7/27/32
3 5/19/32	3 8/ 3/32
4 5/26/32	4 8/17/32
5 6/ 2/32	5 8/24/32
6 6/ 9/32	6 9/ 7/32
7 6/16/32	7 9/14/32
8 6/30/32	8 9/21/32
	9 10/26/32
	10 11/30/32

At the end of three months, the external swelling of the clavicle had disappeared and the patient was described as being symptom-free. Follow-up X-ray taken November 2, 1932 shows almost a complete disappearance of the destructive process involving the left clavicle, though some periosteal thickening of the bone is still present (Fig. 2).

CASE II—E. S., a colored woman of twenty-three years, was admitted to the Surgical Service of the Harlem Hospital October 14, 1932, with the history of having attempted to forcibly open a door on October 1, 1932, and following this strenuous manoeuvre felt a sudden sharp pain in the region of the right clavicle. She noted shortly thereafter that a lump about the size of a lemon had appeared which was tender on palpation. The lump had gradually increased in size.

Past history negative except for usual childhood diseases, appendectomy 1916, gonorrhoea and lues denied. Family history negative. Patient married—no children, no

miscarriages Physical examination negative except for the local surgical condition There is an ovoid swelling involving the clavicle at the junction of the middle third and medial third which is tender and movement of the right arm causes pain at the site of the swelling

Laboratory Data—Urinalysis negative Hemoglobin, 75 per cent , red blood-cells, 4,370,000, white blood-cells, 11,000 Polymorphonuclears, 79 per cent , lymphocytes, 21 per cent Kahn, 4 plus

X-ray No 12634, taken October 8, 1932, showed a transverse fracture of the right



FIG 4—(CASE II) Fracture through a luetic clavicle of the osteoperiosteal type The point marked (aa) indicates the area of marked periosteal thickening and (bb) the site of fracture In addition to this there is an associated subacromial bursitis with calcific deposits

clavicle about four centimetres distal to the sternoclavicular articulation Excellent position of fragments There is rarefaction of the clavicle in the region of the fracture with increased periosteal reaction and thickening involving the distal part of the clavicle In addition, several refractile bodies appear in the region of the subdeltoid bursa (Fig 4)

Diagnosis—(1) Syphilis of clavicle with pathological fracture (2) Subdeltoid bursitis or luetic bursitis with refractile bodies

CASE III—M B, a colored female of thirty years, was admitted to the Surgical Clinic of the Harlem Hospital with complaint of pain and swelling of the right clavicle of

SYPHILIS OF THE CLAVICLE

six months' duration. The patient states that she does not remember having received any trauma to that region or having engaged in any strenuous exercise. Onset of pain followed the appearance of a swelling which at the present time is about the size of a small lemon.

Physical examination negative except for the right clavicle, in the midpoint of which is a rounded swelling about the size of a small lemon, firm and apparently attached to the clavicle.

First Wassermann reported as being negative but the second blood examination taken after a provocative injection of neoarsphenamine, Gm 0.15, was reported as being 4 plus.

Radiograph of the clavicle (Fig. 5) showed the clavicle thickened throughout its



FIG. 5—(CASE III) Fracture through a luetic clavicle of the osteoperiosteal type. Point marked (a) indicates the site of fracture and (b) the periosteal thickening of the corpus of the clavicle.

midcorpus with marked periosteal thickening. At the junction of the middle and proximal thirds, there is a fracture with excellent apposition of fragments. The clavicle is the site of a morbid process which gives an impression of being luetic in character.

Diagnosis—Gumma of the clavicle with pathological fracture.

At the present time the patient is receiving antiluetic treatment in the form of intravenous neoarsphenamine and potassium iodide by mouth.

Conclusions—(1) Three cases of luetic involvement of the clavicle are presented, two of which revealed pathological fractures.

(2) The lesion is not observed as frequently as formerly owing to the more widespread routine treatment of the disease For this reason its existence is even more unusual

(3) Diagnosis is made on the four criteria of history, X-ray, Wassermann, and reaction to specific therapy The clinical symptoms are in no wise in proportion to the extent of the clavicular involvement

(4) Differential diagnosis is to be made from sarcoma, tuberculosis and in the hyperostotic form of lues from Paget's disease of the clavicle

(5) The response to specific therapy is striking and rapid and the value of the provocative dose of antiluetic treatment is to be emphasized

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ACUTE PANCREATITIS

BY CYRUS F HORINE, M D

OF BALTIMORE, MD

FROM THE DEPARTMENT OF SURGERY OF THE SCHOOL OF MEDICINE OF THE UNIVERSITY OF MARYLAND

THE author reports, herewith, thirteen cases of acute pancreatitis treated at the University Hospital within the past ten years. Cases II and IX were treated by the author.

Male, five cases, female, eight cases. Average age, forty-three years. Glycosuria, one case, fat necrosis, nine cases. Average leucocyte count, 20,022. Gall-bladder disease, eight cases. Mortality, six deaths, or 46.15 per cent. Cases II, IX, X, cultures negative. Case II had associated suppurative appendicitis. Case IV had associated complete obstruction of ileum near cæcum. Case X had been ill for two days with alcoholism. Case XIII had been treated for more than one year for pernicious anæmia. Cases XII and XIII had "tight gall-bladder" but no definite gall-bladder pathology upon gross examination.

TABIE I

Cases of Acute Pancreatitis

CASE I—(No 63,443) Mrs E R, aged fifty. Admitted, June 16, 1929. Duration of illness before admission—forty-eight hours. Blood chemistry—148 milligrams sugar before operation, 386 milligrams after operation. Glycosuria, positive. Fat necrosis, positive. Leucocyte count, not made. Gall-bladder disease, negative. Died.

CASE II—(No 24,835) H D, aged forty-nine. Admitted, May 26, 1921. Duration of illness before admission—forty-eight hours. Blood chemistry, not taken. Glycosuria, negative. Fat necrosis—positive. Leucocyte count—25,800. Stones in gall-bladder. Cured.

CASE III—(No 43,978) Mrs W G, aged forty-three. Admitted, June 28, 1925. Duration of illness before admission—twenty-four hours. Blood chemistry, not taken. Glycosuria, negative. Fat necrosis—positive. Leucocyte count—16,650. Gall-bladder disease, negative. Cured.

CASE IV—(No 32,318) Mrs M B, aged seventy-one. Admitted, January 1, 1923. Duration of illness before admission—forty-eight hours. Blood chemistry, not taken. Glycosuria, negative. Fat necrosis—positive. Leucocyte count—19,700. Stones in gall-bladder. Died.

CASE V—(No 63,810) Mrs A W, aged sixty-three. Admitted, July 10, 1929. Duration of illness before admission—forty-eight hours. Blood chemistry, not taken. Glycosuria, negative. Fat necrosis—negative. Leucocyte count—28,100. Gall-bladder disease. Empyema. Died.

CASE VI—(No 48,732) Mrs A J, aged twenty-six. Admitted, June 18, 1926. Duration of illness before admission—forty-eight hours. Blood chemistry, not taken. Glycosuria, negative. Fat necrosis—positive. Leucocyte count, not taken. Stones in gall-bladder. Died.

CASE VII—(No 55,487) Mrs E A, aged forty. Admitted, October 10, 1927. Duration of illness before admission—thirty-six hours. Blood chemistry—98 milligrams sugar. Glycosuria, negative. Fat necrosis—negative. Leucocyte count—10,850. Stones in gall-bladder. Cured.

CASE VIII—(No 49,780) Mrs K M, aged forty-four Admitted, September 1, 1926 Duration of illness before admission—twenty-four hours Blood chemistry—chlorides 250 milligrams CO₂ 65 N P N 38 Glycosuria, negative Fat necrosis—positive Leucocyte count, not taken Stones in gall-bladder Died

CASE IX—(No 64,086) E B, aged twenty-four Admitted, July 30, 1929 Duration of illness before admission—twenty-four hours Blood chemistry, not taken Glycosuria, negative Fat necrosis—negative Leucocyte count—16,700 Gall-bladder disease, positive Cured

CASE X—(No 66,431) W M, aged twenty-one Admitted, January 1, 1930 Duration of illness before admission—forty-eight hours Blood chemistry—four days after operation N P N 32, sugar, ninety-nine, chlorides, 290 Glycosuria, negative Fat necrosis—positive Leucocyte count—19,000 Gall-bladder disease, negative Died

CASE XI—(No 65,743) C W, aged twenty-eight Admitted, November 27, 1929 Duration of illness before admission, not given Blood chemistry—N P N 32 milligrams, sugar, 74 milligrams, chlorides, 250 milligrams Glycosuria, negative Fat necrosis—negative Leucocyte count—18,200 Gall-bladder disease, positive Cured

CASE XII—(No 70,174) C W, aged forty-one Admitted, September 26, 1930 Duration of illness before admission—five days Blood chemistry, not taken Glycosuria, negative Fat necrosis—positive Leucocyte count, not taken Gall-bladder disease, negative Cured

CASE XIII—(No 70,092) Mrs C M, aged fifty-seven Admitted, September 21, 1930 Duration of illness before admission—twenty-four hours Blood chemistry, not taken Glycosuria, negative Fat necrosis—positive Leucocyte count—25,200 Gall-bladder disease, negative Cured

The etiology of acute pancreatitis is unknown Schmieden¹ found associated gall-bladder disease present in 69.8 per cent of 1,278 collected cases In our group there were eight cases having associated gall-bladder disease Deaver,² Maugelet,³ Arnsperger,⁴ and others believe there is a bacterial invasion into the pancreas, from the gall-bladder, by the way of the lymphatic system Cultures taken in three of our cases, two of which had associated gall-bladder disease, showed a negative culture in each case Two of the cultured cases had fat necrosis This evidence does not support the bacterial theory Cultures were taken from the peritoneal fluid

Many investigators have produced acute pancreatitis by injecting bile into the pancreatic ducts Wolfer⁵ gives a rather complete bibliography of the work that has been done to produce acute pancreatitis experimentally Opie, E L⁶ and Guleke⁷ believe there is a primary necrosis in acute pancreatitis which is followed by secondary hæmorrhage and suppuration

Clinical pictures show a variation in the character of the onset, severity and duration of symptoms, but the pathological findings are not always in proportion to the severity and duration of the symptoms Three cases (Nos V, VII and IX) of our group, had an onset of violent symptoms, lasting from twenty-four to forty-eight hours, and, at operation, there was no hæmorrhage, liquefaction or necrosis The pancreas in each case was swollen, firm and œdematous Other cases (Nos II, VI and XII) showed moderate severity of symptoms lasting forty-eight hours to five days, and, at operation, hæmorrhage, liquefaction and necrosis were found

Symptomatology—The predominating symptom in acute pancreatitis is pain. Usually the pain is a violent, "seizing pain," sudden in onset, and may be followed by rapid respirations, rapid feeble pulse, cyanosis and some times collapse. The pain is confined to the upper abdomen and in some cases to the left of the mid-line along the costal margin. Frequently the pain is not relieved by morphine. Halsted,⁸ Bailey⁹ and Turner¹⁰ have described a peculiar type of cyanosis. Halsted described the cyanosis of the face and skin as a slate-blue color. Tenderness is found chiefly in the upper abdomen above the umbilicus or along the left costal margin. The abdomen may be soft and show distention rather than rigidity. Some authors describe a sensation on palpation of the upper abdomen as a "doughy mass." Nausea and vomiting are frequent initial symptoms.

Diagnosis—In the diagnosis of acute pancreatitis the following conditions have to be differentiated: (1) Coronary thrombosis, (2) perforated ulcer, gastric and duodenal, (3) gall-stone colic, (4) kidney colic, (5) intestinal obstruction, (6) mesenteric thrombosis, (7) gastric crises, (8) ruptured ectopic pregnancy, (9) appendicitis, (10) twisted pedicle ovarian cyst, and (11) pneumoperitoneum.

Acute pancreatitis may be difficult to differentiate from certain cases of angina, especially the types of angina abdominis. A history of previous attacks of angina may be obtained. Tenderness and distention are not apt to occur in the cases of angina. In perforated ulcer there may have been a previous history of ulcer, either of gastric or duodenal type. Vomiting is *seldom seen* in cases of perforated ulcer. Vomiting is often seen in acute pancreatitis. A slow pulse is frequently observed in perforation, if the case is seen early. The opposite is true in the pancreatitis case. Board-like abdominal rigidity is more apt to be found in perforated ulcer while distention is usually found in pancreatitis. The two conditions are often confused because both frequently follow the ingestion of a large meal.

Associated gall-bladder disease is seen in 70 to 90 per cent of cases of acute pancreatitis. This complicates the differential diagnosis, however, gall-bladder symptoms are more or less confined to the upper right abdominal quadrant. It is more apt to be confused with the more severe type of biliary disease, such as empyema or bile-duct obstruction. In bile-duct obstruction or empyema, chills, sweats and fever are common. Septic features are uncommon in early acute pancreatitis.

Kidney stone or especially ureteral calculus may present acute abdominal symptoms simulating acute pancreatitis. History of previous attacks may be obtained. Chills, sweats, fever, hæmaturia and pyuria would help to differentiate the above from acute pancreatitis. In addition, the pain in kidney disease radiates as a rule to the groin or genitalia.

Perhaps acute pancreatitis is mistaken more frequently for acute intestinal obstruction than any other condition. In consideration of all the various causes of obstruction, the first point to rule out is the history or evidence of previous operation. Strangulation of a loop of intestine through internal

hernial openings, such as diaphragmatic, sciatic, paraduodenal, pudendal or obturator foramen may be difficult to rule out. An X-ray examination of the chest may reveal a suspected diaphragmatic hernia. A strangulated sciatic or pudendal hernia may be palpated by rectal or vaginal examination. Strangulated obturator hernia often presents pain along the inner side of the thigh, radiating to the knee-joint (Howship-Romberg sign). The pain in pancreatitis is more apt to be confined to the upper abdomen. The pain in obstruction is more paroxysmal and generalized. Tenderness is more marked in the case of acute pancreatitis.

The picture in mesenteric thrombosis may be very similar to that of acute pancreatitis. One may find evidence of cardiovascular disease which may be a predisposing cause of mesenteric thrombosis. In mesenteric thrombosis blood and mucus may be found in the stools.

Gastric or tabetic crises may present symptoms like those seen in acute pancreatitis, *i.e.*, vomiting, pallor, sweating, collapse, and sudden severe epigastric pain which is referred to the back. Osler states rare cases have died in collapse. It is, therefore, very important to know if there is a history of a syphilitic infection, and a history of bowel and bladder disturbances. The presence of Argyll-Robertson pupil, the loss of knee kicks and a positive spinal fluid would help to differentiate the two conditions.

Pain, nausea, vomiting and collapse are seen in ruptured ectopic pregnancy and this condition may be confused with acute pancreatitis. One of the most characteristic symptoms seen in ruptured ectopic pregnancy is exquisite tenderness in the lower abdomen. There is hardly any acute abdominal accident that presents so much tenderness. The history of absence of menstruation and the presence of bloody vaginal discharge for one or two months would help to make the differential diagnosis.

One of the most frequent causes of acute abdominal pain is acute appendicitis. The pain in this condition is not quite so severe. Original epigastric pain is apt to localize in the lower right quadrant. A very constant symptom of acute appendicitis is pain in McBurney's region produced by coughing. Tenderness is found in the lower right quadrant rather than in the epigastrium.

Ovarian cyst with a twisted pedicle is another acute condition followed by sudden, sharp, colicky pain, nausea, vomiting and perhaps collapse. It is very much like the picture of intestinal obstruction. Tenderness and pain are more apt to be confined to the lower abdomen. A mass may be palpated by vaginal examination.

Pneumoperitoneum is always secondary to some other pathology such as a perforated gastric duodenal or intestinal ulcer. It is possible that pneumoperitoneum may be secondary to a pneumomediastinum. Therefore, an examination or X-ray of the chest may help to eliminate a case of pneumoperitoneum. In this case the peritoneal cavity may be charged with gas under tremendous pressure which could not be mistaken for acute pancreatitis. Pneumoperitoneum secondary to perforation of an abdominal viscus would

be more confusing. The differential diagnosis would be the same as that given above in perforated ulcer.

The writer has purposely omitted one point in the differential diagnosis of acute pancreatitis over the other conditions discussed. In the cases reported herewith, a leucocyte count had been made in eight cases with an average count of 20,022, the highest count in any two cases was 28,100 and 25,800 while the lowest count in any two cases was 10,850 and 16,650 per cubic millimetre. I believe this to be the most important point in the statistical study of the cases reported. Marked leucocytosis is not found in coronary thrombosis, early perforated ulcer, intestinal obstruction, mesenteric thrombosis, gastric crises, ectopic pregnancy, twisted pedunculated ovarian cyst or pneumoperitoneum. It may be found in acute infectious gall or bile-duct disease or acute appendicitis. It is also present, late in the perforation of an abdominal viscus. The leucocyte count in acute appendicitis, as a rule, is not quite so high.

Treatment—Korte¹² (1898) believed that operation should be delayed until the development of the subacute stage. Later¹³ (1911) he advocated early operation. Most men now agree that early operation should be done. The hyperacute cases may make an exception to this rule (Archibald¹⁴). These patients may be given hypertonic salt and glucose solution prior to operation while waiting for recovery from the primary shock. Lahey¹¹ gives fifty milligrams of glucose in 750 cubic centimetres of salt solution to restore a reduced glycogen balance.

Six of this group of cases were operated upon after they had been ill forty-eight hours before admission to the hospital. There were five deaths. Four cases were operated upon after a lapse of twenty-four hours from the onset of illness. One of this group died. Yet one patient who had been ill five days before operation recovered.

There is still a difference of opinion about the procedure to be followed in draining the bile-duct apparatus. Some men believe in cholecystectomy which seems to be a rather radical procedure. The gall-bladder was drained in all of these cases. If the disease should be due to the entrance of bile into the pancreatic ducts it would appear that cholecystostomy with subsequent drainage of bile to the exterior is the logical operation on the bile-duct apparatus. Another point in discussion is the question of blunt dissection of the pancreas. The pancreas may be dissected very cautiously with the finger where there are multiple abscesses, yet it must be kept in mind that considerable hæmorrhage or injury to larger ducts may be the result of this dissection. A dissection of this sort was done in Case XIII of this group without any subsequent complications. The duration of illness, prior to operation in this case was twenty-four hours. Large necrotic areas had developed and much of the pancreatic tissue sloughed away.

In addition to drainage of the gall-bladder the capsule of the pancreas was incised and drained in all of these cases. Cigarette drains were used around the capsule. One cigarette drain was also placed down to the epiploic

foramen Zinc oxide or 2 per cent hydrochloric-acid ointment may be applied around the incision if pancreatic ferments digest the wound

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STUDY OF THE BLOOD-PLATELETS AFTER REMOVAL OF A RUPTURED SPLEEN¹

BY BENJAMIN RICE SHORE, M D AND KATHERINE V KREIDEL, A B
OF NEW YORK, N Y

STUDIES of the blood-platelets after splenectomy for the rupture of an otherwise normal spleen are sufficiently rare to warrant the report of the following case

CASE REPORT—The patient, a boy eleven years of age, was injured about eight o'clock in the evening by an automobile, which struck him on the right side and knocked him to the pavement. He was not unconscious and was able to rise unassisted to his hands and knees. There was no nausea or vomiting. He was somewhat disoriented. He was brought direct to the Vanderbilt Clinic and was transferred to the Babies Hospital two hours later. By this time he had vomited and was showing signs of shock. Shortly after his admission to the hospital he was given an infusion of 300 cubic centimetres of 10 per cent glucose which improved his condition temporarily. At midnight, four hours after his injury, he began to vomit blood and by this time showed all the classical signs of hæmorrhage.

Examination showed contusions about the face and definite evidences of a fracture through the right ramus of the mandible. The left hip and thigh were also bruised. The abdomen was soft and relaxed and no tenderness, spasm, or shifting dullness could be elicited. As he was obviously in shock from loss of blood and fluoroscopical examination of the chest had eliminated hæmorrhage into the pleural cavity, the diagnosis of a ruptured intra-abdominal viscus with secondary hæmorrhage was made. The only localizing symptom was the vomiting of blood, which is commonly seen in traumatic rupture of the spleen.

Operation—He was transfused with 400 cubic centimetres of whole blood and immediately afterward the abdomen was opened under local anæsthesia through a left rectus incision. The peritoneal cavity was completely filled with fresh and partly changed blood which welled up into the wound as rapidly as the field was dried. Open ether anæsthesia was begun at this point. Exploration showed all of the tissues in the left side of the abdomen including the mesocolon to be suffused with extravasated blood. The spleen was identified and a large rent was felt across its convex surface. The splenic pedicle was grasped between the index and middle fingers of the left hand, a clamp was placed distal to this, the pedicle was divided and the spleen removed. The pedicle was ligated with a transfixion suture of plain catgut, several other bleeding vessels were ligated and the splenic bed was left dry. The abdomen was closed in layers without drainage. The patient made a satisfactory post-operative recovery, his temperature being normal on the fourth day after operation. He was discharged from the hospital on the seventeenth post-operative day.

Pathological Report—Examination of the spleen showed a tear on the diaphragmatic surface five centimetres long which extended through the underlying parenchyma to the visceral surface of the organ. On the latter surface there was another tear four centimetres long which was continuous with the one just described. Microscopical examination showed normal splenic tissue.

¹ From the Babies Hospital, New York, N Y

Follow-Up—The blood of this patient has been watched with considerable interest since the day of his operation (Fig 1) The hæmoglobin, which was 60 per cent at the time of operation, has gradually but steadily increased to between 80 and 90 per cent, and the red blood-cells have increased from 2,700,000 to 4,584,000 per cubic millimetre There has been

Date	Hb	R B C	Platelets	W B C	P	L	M	E	Miscellaneous
5-27-31	60%	2,776,000	392,000	9,050	74	25			Myelocyte 1
5-28-31	68%	3,016,000	432,000	9,000	87	12			Myelocyte 1
5-30-31	60%	3,272,000	408,000	9,000	81	18		1	
6- 2-31	60%	3,424,000	632,000	10,950	81	17	1	1	
6- 4-31	65%	2,896,000	984,000	8,750	77	20		2	Myeloblast 1
6- 5-31	65%	3,446,000	1,328,000	11,900	80	10	6	1	Myeloblast and myelocyte 1
6- 6-31	68%	3,832,000	1,488,000	8,400	85	13	1	1	
6- 8-31	70%	3,880,000	1,640,000	13,650	79	18	2	1	
6- 9-31	70%	3,424,000	1,600,000	10,050	67	28	5		
6-11-31	70%	3,600,000	1,576,000	6,750	71	26	3		
6-13-31	78%	4,088,000	1,404,000	6,300	63	25	11	1	Normal clot retraction
6-24-31	80%	4,088,000	576,000	7,700	40	44	10	6	Reticulocytes 0.6%
7- 9-31	88%	4,128,000	728,000	7,900	40	49	11		
8- 5-31	90%	4,192,000	560,000	8,350	40	54	4	2	
9-17-31	80%	4,016,000	664,000						
10-22-31	90%	4,040,000	728,000	7,050	34	50	12	4	
1-13-32	80%	4,584,000	784,000	8,150	51	44	2	3	

FIG 1—Blood counts following splenectomy for traumatic rupture of a normal spleen

no essential change in the total white count, which has been around 8,000 The differential count has shown a gradual but steady increase in the lymphocytes, the last count being 51 per cent polymorphonuclear leucocytes, 2 per cent monocytes, 3 per cent eosinophiles, and 44 per cent lymphocytes The chief interest, however, lies in the careful study of the blood-platelets The

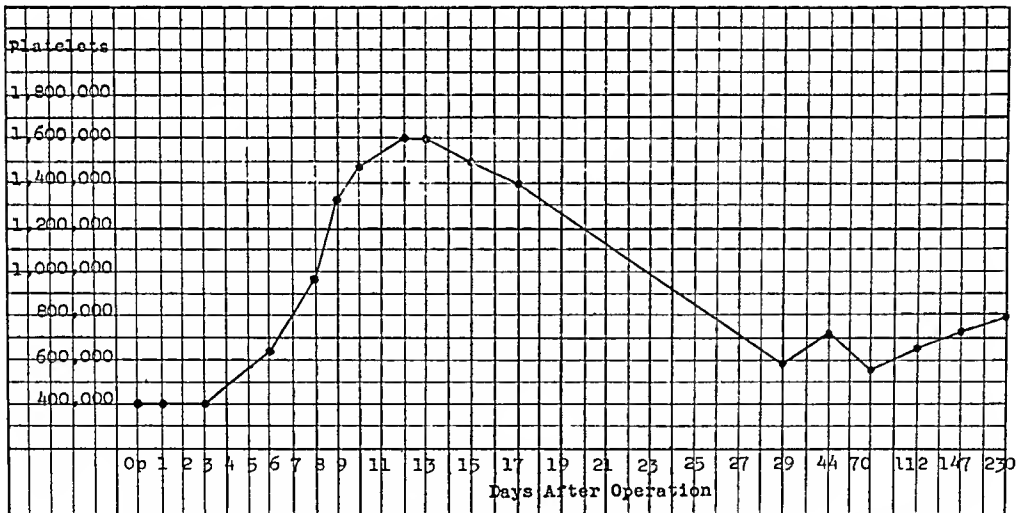


FIG 2—The curve of the platelet counts following the removal of a ruptured spleen

first count done five hours after splenectomy showed 392,000 platelets per cubic millimetre Daily counts showed the number of platelets to remain at this level until the sixth post-operative day, when they increased to 632,000 After that they rose rapidly to reach a peak of 1,640,000 on the twelfth day This level was maintained for five days and then fell to its present level, which is around 700,000, seven and one-half months after operation (Fig 2)

DISCUSSION—The behavior of the blood-platelets after the removal of diseased spleens has become well known from the study of many cases. Careful studies of the platelets after splenectomy for rupture of a normal spleen are, however, rare. Such a case was reported by Evans,¹ in 1928, and is the only one which can be found in the recent literature. The first count done on Evans' patient showed 900,000 platelets on the tenth post-operative day. These rose to 1,100,000 on the thirteenth day and reached a maximum of 1,305,000 on the seventeenth day. They gradually fell, and the last count, which was done on the forty-first day after splenectomy, showed 650,000 platelets. The patient unfortunately died of intestinal obstruction on the sixty-fourth day, making a prolonged follow-up impossible.

The reaction of the platelets in this patient of Evans' and the one reported here after splenectomy for traumatic rupture is strikingly similar to that observed by Dawbarn, Eailam, and Evans² after other surgical procedures exclusive of splenectomy. These observers studied fifty unselected surgical cases and found a marked rise of the platelets which was manifested about the sixth post-operative day. This reached a maximum in about ten days which represented on the average an increase of 150 per cent of the original count. This high level was maintained for a further few days and then the counts gradually returned to normal. The composite curve of the platelet counts in these fifty unselected surgical cases is identical to the curve of the platelet counts of the case here reported.

Other series of cases confirm the observations of Dawbarn, Eailam, and Evans. Hueck³ reported the same results in 100, and Normann⁴ in sixty unselected surgical cases exclusive of splenectomies. Included in this latter study were operations on the gall-bladder, stomach, perineum, bones, thorax, and kidneys. In these there was a marked post-operative increase of platelets which reached a maximum on the tenth to fourteenth day. This effect could not be ascribed to the anæsthetic as the same results were observed with the use of local anæsthesia. Since a similar rise was found in three traumatic cases without operation, the conclusion was drawn that the platelet rise was probably dependent upon absorption of toxic products from injured tissues and entirely independent of the type of the operation.

Experimental removal of normal spleens in animals has given platelet reactions which are identical with that seen in this case of splenectomy for rupture of a normal spleen. Steiner and Gunn⁵ found that the removal of the spleen in rabbits was followed constantly by an increase in the number of circulating blood platelets. They also observed that other operations involving a similar degree of trauma were followed by an increase of platelets which did not differ in time of occurrence, degree or duration from that observed after splenectomy. The degree of the rise apparently depended upon the amount of trauma sustained by the tissues. Kumbhaar,⁶ working with dogs, found an immediate rise in the blood-platelets after splenectomy but it is not stated if this is in terms of hours or days.

In this connection it must be remembered that while the type of platelet

reaction after splenectomy for thrombocytopenic purpura is the same as described for traumatic rupture of a normal spleen, the time of its onset is entirely different. Starting with a count below normal, an increase of the blood-platelets is observed in favorable cases as soon as one hour after splenectomy. This increase is rapid and reaches a peak far above the normal level in from six to ten days. To illustrate this one patient with thrombocytopenic purpura had a platelet count of 20,000 before operation which increased to 100,000 one and one-half hours after splenectomy. Daily counts demonstrated a rise to the maximum of 1,000,000, which was reached on the seventh post-operative day. It is evident, therefore, that splenectomy for thrombocytopenic purpura produces a platelet crisis which differs in its time of occurrence from that seen after other surgical operations and after the removal of a ruptured spleen.

Summary—Studies of the blood-platelets following splenectomy for the traumatic rupture of an otherwise normal spleen showed a post-operative increase beginning on the sixth and reaching a maximum of 1,640,000 on the twelfth post-operative day. In its time of onset and degree this platelet crisis was similar to that seen after other surgical operations exclusive of splenectomy. The onset six days after operation was, however, entirely different from the immediate rise observed after splenectomy in favorable cases of thrombocytopenic purpura. A platelet count of over 700,000 has been maintained by this patient for the seven and one-half months during which his case has been followed.

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CHRONIC DUODENAL ILEUS

BY ERNST KRAAS, M D , AND WILLIAM C BECK, M D

OF FRANKFURT, A/M, GERMANY

FROM THE UNIVERSITY SURGICAL CLINIC IN FRANKFURT, A/M, GERMANY, PROFESSOR V SCHMIEDEN, DIRECTOR

CHRONIC duodenal ileus has been discussed in the literature under a variety of headings, such as chronic duodenal stasis, megaduodenum, chronic arterio-mesenteric occlusion, chronic intermittent duodenal ileus, *etc* Therefore, only for a valid reason may one dare to add another term. The pathological process is indeed a complicated one, and it is our purpose to attempt a classification which will somewhat clarify the pathogenesis, and form a working basis for a therapeutic method. The title is chosen on the ground of the proposed classification.

History—The first report appearing in the literature referring to duodenal ileus dates back to 1752 written in Latin by Boernerus. He related a case of almost complete constriction of the duodenum. In his article he refers to the previous work of Alsies and Sylvester on a similar subject. The next case appears reported by A. de Haen in 1763, in which the duodenum was compressed by the head of the pancreas, although he makes no mention of the nature of the pancreatic disease. Yeats (1820) wrote that obstruction of the duodenum may take place by compression of the transverse colon. He discussed the symptomatology, and included a description of the toxic manifestations. In 1829, the first case of congenital stenosis was reported by Guyot. The first case of obstruction by carcinoma complicated by perforation was described by Fullet, in 1833.

Obstruction of the duodenum by carcinoma of the head of the pancreas was reported by Mondiniere in 1836, Holscher in 1840, Tanner in 1842, and again by Tiesser in 1847. In 1848 Anderson described a stricture of the duodenum. The following year Rokitsanski suggested the relation of acute dilatation of the stomach to compression of the duodenum by the root of the mesentery.

Inler and Humby, in 1853, give an account of the relation of acute gastric dilatation to duodenal obstruction, and in 1852 Fagge described a case of acute gastric dilatation, with the post-mortem findings of duodenal obstruction and perforation. Bamberger (1855) reviewed the same subject. During the same year Heschl considered the compression of the duodenum by the root of the mesentery. The condition was again discussed by Brinton, in 1859. In 1886, Cahn wrote an article on the compression of the descending part of the duodenum by a sarcoma in the retroperitoneal lymph-nodes. During the same year the first case of duodenal obstruction by a gall-stone at the mouth of the common duct was mentioned by Riedel. Glenard (1889) suggested that traction from the dilated stomach causes narrowing of the duodenal-jejunal junction, and remarked that the condition was not one of tremendous rarity.

In 1890, Reiche reported a case of infrapapillary duodenal obstruction, just admitting the little finger, with periduodenal peritoneal adhesions as the etiological factor. The discussion was carried on by Kundrat, in 1891, who reported three cases of mesenteric obstruction, and in 1895 by Schmitzler. During the years 1852 to 1890, eighteen cases were collected of duodenal obstruction by pancreatic disease and duodenal carcinoma*.

In 1897, Dwight made wax casts of the duodenum demonstrating the U, V and S shapes, as well as the depression caused by the passage of the mesenteric vessels over

* For a reference to the cases see Anders, *Am Jour Med Sci*, pp 144, 360, 1912

the organ. Two years later Albrecht reported two cases and observed that if one placed a cadaver in a dorsal position and inserted the finger into the duodenum by traction on the mesentery in a downward and backward direction, a compression of the same could be demonstrated. He stated that such traction occurs clinically if the small intestine occupies the pelvis.

In 1900, Robinson reported the clinical and autopsy findings in duodenal obstruction, and in the same year Petit cured a case by suturing the jejunum to the transverse mesocolon. The first large series of cases was published by Thomson in 1902, whose monograph embraced an experience with some forty-four cases. Three years later Neck reviewed forty cases, which he compiled, and in 1908 Laffer reviewed the literature on the subject up to that time in a comprehensive article and included the compiled reports of 217 cases.

Since the beginning of the century a great deal has been written on the subject. The important contributions will be referred to in the following pages.

Etiology—The cause of the dilatation of the duodenum certainly is not explained by one single abnormal process. The duodenum may assume a dilated state as a result of various factors which act either separately or in combination. According to all authors (Holmes), the dilated state is not a necessary companion of duodenal ileus. It is, however, almost always present, and, if present, is an invariable indication of duodenal stasis. Because of its development and anatomical relations it is particularly liable to produce a chronic obstruction.

The American and English authors are inclined to ascribe the dilated duodenum to demonstrable mechanical causes. Melchior, Duval, Schmieden and Kraas, as well as other continental authors describe cases, however, where no such causes are traceable, and reserve for these processes the name "true megaduodenum."

To understand the "true megaduodenum" one must refer to the embryological development of the duodenum. The stomach and the proximal part of the small bowel develop during the latter half of the third embryonal week, as a thickening of the enteric tube, just below the incipient bud (Anlage) of the lung. Tandler has shown that between thirty and sixty days there occurs an overgrowth of epithelium so that the duodenal lumen is more or less completely obliterated.

This process is followed by a vacuolization of the epithelial mass. The vacuoles enlarge and the walls between them break down so that a continuous lumen is formed. An analogy is observed in the embryological development of the œsophagus. Tandler believed that if the vacuolization process was retarded, duodenal stenosis or even atresia might result. Forssner, Kreuter, Anders and Broman agree with Tandler in his anatomical findings and conclusions. To the inquiry of Lubarsch, why duodenal stenoses are then not more frequent in comparison with other intestinal stenosis, Tandler answered that when a comparison to the length of the organs is made, duodenal stenoses are fifteen times as common as stenosis in other parts of the intestinal tract.

Schmieden and Kraas suggest that if one accepts the congenital nature of the true megaduodenum, one might think of the possibility that this might be an overvacuolization. They, however, concede that the only embryological evidence to support such a theory is proposed by Noel. He found a coincident mesenterium commune in three cases. The presence of a true megaduodenum is supported by the findings of Melchior, Haberer, Duval, Mark and others of a dilated duodenum without evidences of stenosis or constriction even cases where the dilatation beyond the duodeno-jejunal junction extended for a considerable distance down the jejunum. Duval believed that these cases belong

to the idiopathic congenital segmental intestinal dilatations. This contention is confirmed by a case from our clinic where the dilatation of the duodenum was associated with a marked, well-defined dilatation, about eight centimetres in length, of the left half of the transverse colon.

Congenital atresia and congenital stenosis, which may be explained by Tandler's hypothesis, are reported in the clinical literature. Little and Helmholtz, in 1905, collected twenty-seven cases while Cordes collected some forty-eight cases of atresia and nine of stenosis.

The organ undergoes other changes in its developmental anatomy which render it liable to variations, these in turn being possible of producing extrinsic stenosis. Up to the fourth month of fetal life, the duodenum possesses a mesentery and swings freely in the abdominal cavity. At this time the duodenal mesentery becomes shorter and shorter and the organ is drawn against the posterior abdominal wall, there to lie retroperitoneally. Simultaneously, the right half of the colon is drawn posteriorly, crossing the descending ramus of the duodenum and uniting with the transverse mesocolon. Here exists an opportunity for the occurrence of anomalies.

The duodenum may retain its mesentery (*duodenum mobile*) and swing freely in the peritoneal cavity. Such a case is reported by Freeman, wherein a kink was produced at the duodeno-jejunal junction which was fixed at the ligament of Treitz.

When the duodenum has reached its adult retroperitoneal position it has assumed one of the several forms first described by Dwight. Its relations are of extreme importance in a further discussion of the different means by which it may become obstructed and therefore it may be of value to review these.

In the concavity of the duodenal curve the pancreas is molded. The descending ramus lies upon the hilus of the right kidney, and, usually, is also in a certain relation to the corresponding suprarenal gland. Medialward is the course of the inferior vena cava. In the fold between the duodenum and the pancreas lies the common bile-duct. The anterior surface of the descending ramus is covered by the transverse colon and the gall-bladder.

The transverse or inferior part of the duodenum lies upon the inferior vena cava and the abdominal aorta, to which it is fixed by loose areolar tissue. Above it lies the pancreas, and anteriorly it is crossed by the mesenteric vessels, the artery to the left of the vein. The rest of it is covered anteriorly by the free loops of small intestine. The relation of the ascending ramus are of lesser importance, in case one should care to consider this as a separate division. Thus we see that the inferior or transverse ramus of the duodenum lies in an angle produced by branching of the mesenteric vessels from the large abdominal ones. Variations of the shape of the duodenum as described by Dwight and Merkel cause only minor variations in the anatomical relations.

Since the duodenum lies in such close proximity to organs which may be anomalous it is not surprising that compression may occur. The annular pancreas represents one such anomaly. It is comprehensively described by Guleke. The mesenteric vessels produce a definite constriction in the duodenum, as may be shown by formalin hardening of the duodenum (Merkel).

Valls studied the relation of the duodenum to the right colic arteries. He demonstrated that there are three freely anastomosing right colic arteries, which arise from a concavity in the superior mesenteric, pass between the layers of mesentery, and are bound to the posterior abdominal wall with the mesocolon. In 50 per cent of the cases which he studied the right inferior colic artery passed below the duodenum, while in forty-three, five per cent crossed the third portion obliquely, thus being capable of compressing it and producing a chronic obstruction.

Harris has, on the basis of operative findings, reported chronic duodenal obstruction caused by pressure from the hepatoduodenal ligament. All of his six cases had had feeding difficulties during infancy, and he reports complete cure following division of

this ligament Niles has reported thirty-nine cases of a similar nature, all apparently with good results following analogous therapeutic measures

Other congenital bands have been described and held responsible for deforming the duodenal passage They are by some authors believed to be "crystallizations of the lines of force"

Because of the absence of a duodenal mesentery many of the causes of obstruction which are seen in other parts of the intestinal canal are rarely observed in this organ Volvulus of the duodenum has been reported in the literature by Lebert, Rokitsanski and Rembold, but it is of such rarity that it hardly deserves to be mentioned Intussusception reported by Mayer, Sundlein and Wide, occupies a similar position

Of greater importance are diseases affecting the neighboring organs which in turn produce duodenal compression Several complications of cholelithiasis are capable of producing duodenal stenosis Of first order are those where the gall-bladder filled with stones compresses the duodenum, a condition which has been termed by Melchior "duodenal gall-stones ileus" A second variety is observed, when precholecystic adhesions exert traction on the duodenum Bryant, in an extensive study of visceral adhesions and bands, found the pericholecystic adhesions only second to those surrounding the colon These, approximately equal in both sexes, were found to be present in direct proportion to the age of the patient Such patients usually are considered as suffering from pyloric stenosis, although Tuffier and Marchais had already called attention to the fact that the adhesions run more commonly to the duodenum than to the stomach These adhesions may distort almost any segment of the duodenum, even a low duodenal stenosis being reported by Hochhaus and Riedel Apparently, according to Melchior, these adhesions are found only in cholecystitis accompanied by stones Rather peculiarly, the simple removal of the stones will often relieve all of the signs and symptoms of the duodenal ileus, even though the strands are left, demonstrated by the cases of Severin and others

Diseases of the pancreas may result in a duodenal stenosis Of the anomalies annular pancreas has been mentioned Most common of the acquired diseases are the neoplasms Carcinoma is the only one of importance, although an adenoma has been reported by Neve, and a cyst by Roux Such obstructions usually occur in the lower portion of the organ Inflammatory swellings of the pancreas may also result in stenosis, such as chronic pancreatitis, hæmorrhagic pancreatitis, and necrotic pancreatitis A case of tuberculosis of the pancreas has been reported by Choostet, which produced a duodenal stenosis

Enlargement of the retroduodenal lymph-glands through tumor metastasis or inflammatory disease may also produce compression Similar in action to these is the compression of the duodenum by an aneurism of the abdominal aorta reported by Combessis, and Lebert Perry and Shaw have reported constriction caused by a traumatic hæmatoma, as well as one of compression by a carcinoma of the gall-bladder Stenosis by a tumor of the omentum has been reported by Augagneur, while Frereichs has mentioned constriction by an echinococcus cyst of the liver

Constriction of the duodenum may be from pressure anteriorly by the mesenteric vessels, which brings us to a consideration of the large chapter of the so-called arterio-mesenteric occlusions A great deal of work has been done on this subject, but even today all of the attributed manifestations have not been made clear Two forms of this syndrome exist, an acute and a chronic Rokitsanski first called attention to the acute gastro-mesenteric ileus as the cause of the acutely dilated stomach There has been much work done since, both clinical and experimental, adding to the knowledge and clarifying the pathogenesis An evaluation of these discussions is beyond the range and scope of this paper and will not be attempted

We shall limit ourselves to a consideration of the chronic type of arterio-mesenteric duodenal ileus Glenard, in 1885, considered the chronic ileus as physiological He believed that the physiological purpose was to allow time for the bile and the pancreatic secretion to mix with the gastric chyme This contention has since been proven

DUODENAL ILEUS

false Codman is of the opinion that chronic arteriomesenteric ileus is one of the effects of the change of the manner of living of the human species, the change from the quadruped to the biped position. To prove this contention he reproduces a sketch of a horizontal animal, the mesentery hanging vertically at right angles to the vertebral column and leaving the duodenum free. Then he draws a diagram of a corseted woman, which shows the mesentery again hanging vertically, but in this case compressing the duodenum against the vertebral column, with which it is now parallel.

As has been described above, the duodenum lies in the angle formed by the mesenteric vessels and the abdominal aorta.

It is most logical to surmise that traction on the mesenteric vessels in a downward and dorsal direction will increase the acute angularity of the angle, and therefore produce a compression beyond normal limits. Such traction can be produced if the cæcum and ascending colon swing freely on a mesentery. They are then capable of a prolapse and thus produce the required traction on the mesenteric vessels. Waugh found in several hundred autopsies on children a primitive mesentery on the ascending colon in 20 per cent of all examinations. Kantor, in reporting eighty-five cases of duodenal ileus, states that 35 per cent of these had an associated low cæcum. Bloodgood agrees with such a causation, and has resected the ptotic right colon in such patients.

Crouse presented the possibility of the mesentery of the small bowel being too short. This prevents the intestines from lying on the bony support of the pelvis and therefore pulls on the mesenteric attachment. The work of Albrecht previously referred to shows that in the autopsies on ten enteroptotic cases, "The pressure of the radiæ mesenterii on the horizontal portion of the duodenum was definitely greater than the normal physiologic limits." v. Haberer has pointed out the possibility of small bowel in hernial sacs being pulled downward by adhesions, thus causing traction on the mesenteric root.

Other conditions are capable of exerting traction on the mesenteric vessels. Codman has made the interesting statement that there is less pressure on the duodenum in fat people than in the thin ones, inasmuch as the mesenteric fat tends to distribute the pressure, while in thin people the duodenum is pressed directly against the spine.

A dilated cæcum, iliac stasis, lax abdominal walls, and visceroptosis all can cause mesenteric traction. The question arises, how much traction is needed to compress the duodenum? Dragstedt and Dragstedt have shown that a circular extrinsic pressure of six inches of water is sufficient to cause an acute duodenal obstruction with a fatal result. Much higher pressures are required to compress the jejunum, ileum or colon. Connor has found that traction on the mesentery by a weight of 500 grams will cause a complete occlusion. This is approximately the weight of the empty small intestine. Normally filled small intestine weighs about 2,000 grams.

Into the category of the arteriomesenteric duodenal ileus belongs a condition described by Lane and later on by Jordan, the duodenojejunal kink. Here the duodenum occupies a normal position and is not compressed, but the jejunum, instead of following its course to the left in its usual manner from the ligament of Treitz, either drops perpendicularly, or is even drawn to the right, thus producing a kink. Lane includes this with the ilial kink in a diagnosis of chronic intestinal stasis. Jordan mentions that this kinking can be demonstrated by the fluoroscope only with the patient in an upright position. The duodenum is always dilated, especially in its first and second parts.

We have discussed the developmental and extrinsic abnormalities which may cause dilatation, or stenosis and dilatation, and it remains to consider the intrinsic factors. The duodenum receives its sympathetic innervation from the celiac axis, while the parasympathetic system is found in the plexus of Meissner and Auerbach. According to the work of Frazer, instability in the nervous stimulus does occur, with the result that dilatations and spasms of the intestinal tube are produced. The exact nature and cause of these variations have not been clearly demonstrated. John Hunter has writ-

ten "The tendency toward muscular hypertrophy as the result of repeated forcible contraction is particularly well marked in that of the involuntary type" A J Ochsner demonstrated in 1905 what he believed to be sphincter muscles in the duodenum, to whose spasm the chronic duodenal obstruction might be attributed Two years later, Boothby demonstrated that the so-called Ochsner-muscle was dependent on local muscle spasm Thomson believed that the hypertrophy has been produced because "from an early period it has been worried into overactivity by constant recurring overaction such as would result from habitual incoordination" Summing up, we may state these considerations from the neuromuscular theory of Devine, as one of the etiological factors of duodenal ileus

Mention should be made of Jan Schoemaker's classing a certain group of chronic ileus cases in the same category as the red stomach Here, he has shown, one has to deal with a neurogenical disease, although superficial examination would lead one to consider it to be an inflammatory reaction He has demonstrated that there is only an intensive hyperæmia of the pyloric antrum, without any perivascular exudation

Still another disease of the duodenum may result in stenosis One of us (Kraas) has pointed out elsewhere that in several cases from this clinic duodenal dilatation has been coincident with diverticula of that organ (Fig 1) It is probable that in this instance there is a double developmental anomaly, rather than that the dilatation is secondary to the diverticulum Duodenal neoplasms do occur and have many times been reported as producing chronic obstruction Duodenitis has also been considered as a cause of stenosis partly because of the development of periduodenal adhesions which distort the organ against the abdominal aorta and the vertebral column

Mathews, Delaney and Dragstedt have collected recently from the literature fifteen cases of hyperplastic tuberculosis of the duodenum which produced symptoms of stenosis

FIG 1—Megaduodenum with a diverticulum on the posterior wall of the duodenum

Several authors have mentioned the possibility of chronic duodenal obstruction being the cause of some of the duodenal ulcers Sloan cited fifty-two cases of duodenal ulcer in which there was a coincident narrowing of the duodenojejunal junction by adhesions He considered the ulcer to be the secondary process In view of the fact that so many ulcers are examined at the operating table and in the post-mortem room without the findings of a duodenal obstruction, would it not be more logical to suppose that adhesive strands which result in constriction are derived either from the ulcer directly or from the inflammatory process which either causes or accompanies the ulcers?

Classification—The disease under discussion can be brought about by a heterogeneous variety of etiological factors, and, as the pathogenesis is one of the major indications in the method of therapy, we should like to suggest a classification on a basis similar to that by which intestinal obstruction is classified

Two large groups may be identified

(1) *The adynamic duodenal ileus*—To this class belong all cases where no mechanical obstruction can be observed, *viz*, the true megaduodenum of Duval, Melchior, Schmieden and Kraas, *etc*. The etiology still remains definitely to be cleared up, developmental and neuromuscular theories having been advanced, as well as placing it in a category with Hirschsprung's disease.

(2) *The dynamic chronic duodenal ileus*—To this group belong all cases where a mechanical hindrance to the passage of the duodenum is discernible. As there are so many different possibilities of method of obstruction we further subdivide this group into

(a) *Intrinsic duodenal lesions*—Here are classed the diseases affecting the



FIG. 2—Megaduodenum with a diverticulum. There is an ulcer niche to be seen on the lesser curvature as well as on the duodenal bulb.

duodenum itself, such as neoplasm, duodenitis, congenital atresia, inflammatory disease (T B), duodenal-jejunal kink, diverticula, *etc*.

(b) *Extrinsic lesions*—Under this heading we group the chronic arterio-mesenteric occlusion (?), peritoneal strands and adhesions, and diseases of the surrounding organs which through pressure produce stenosis.

(c) *Complications of the duodenum mobile*, as hernias, intussusception, *etc*.

The part of the duodenum at which the stricture is produced in the cases of group 2 is, of course, of great importance, both from the standpoint of diagnosis and therapy, perhaps even more so than in obstruction of the small intestine. But in most cases this is determined by the anatomical relations of the etiological factor, and thus self-evident.

Frequency—The frequency of occurrence is of considerable importance. In the American and in the English literature, chronic duodenal ileus has received a great deal of attention, rather in contradistinction to the continent

The former contains several large series of cases. In clinics other than those reporting such series, one often finds that this diagnosis is of an extreme rarity. It may, and probably is, true that often the process is not looked for. The clinical history and physical examination, although suggestive to one who is alert for its occurrence, are far from being clear. The roentgenologist is often interested only in the duodenal bulb, and so overlooks pathological processes in the remainder of that organ.

Goldsmith has quoted Katkoczi as finding 0.6 per cent such duodenal

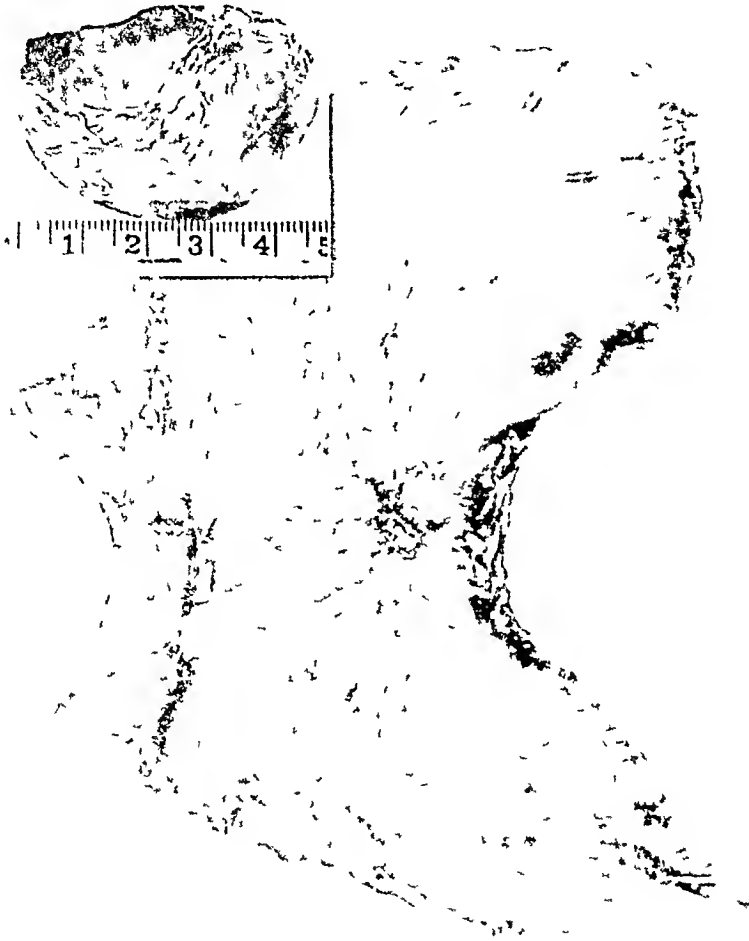


FIG. 3.—Operative specimen showing an ulcer at the pylorus and one on the lesser curvature of the stomach and a dilated proximal portion of the duodenum. Insert shows the duodenal diverticulum removed in this case.

lesions in 4,500 autopsies in the two previous years. Kantor reported that up to 5 per cent of 1,754 patients he examined had the roentgenological evidence of duodenal stasis with dilatation. Jewett, on the other hand, has found the diagnosis only in fifteen out of 30,000 admitted cases in a general hospital.

In general, the condition is somewhat more common in the female. Shattuck and Imboden found it to be so in a ratio of four to one. This may be due to the relaxation of the abdominal muscles following pregnancy. It may also be accounted for, in part, by the greater frequency of gall-bladder

disease in the female, although Bryant has found that there are more adhesions in the male. The patients are usually of middle age, in most cases of the asthenic type.

Symptoms—For an adequate understanding of the symptoms we must have a conception of the physiology of this organ. Three fundamental physiological phenomena are at work, motility, secretion and absorption. Disturbance of one or more of these phenomena will cause definite changes in the organism. But, contrary to the general belief, and contrary to the reports which were given out from many physiological laboratories until recently, the duodenum is not a vital organ. Moorhead and Landes, as well as others more recently, have definitely shown that, with adequate surgical technic, the duodenum may be totally removed with impunity in animal experiments.

What the result is when experimentally a duodenal stenosis has been produced Morton and Sullivan have shown, demonstrating that the secretion in the duodenum undergoes a rapid increase, in contrast to an inertia of secretion in the jejunum and ileum under similar conditions. The duodenum dilates from the greater hydrostatic pressure. Some authors claim that the dilatation is the result of chemical activity, rather than the accumulation of secretion. Berg and Jobling have shown that not only is there a great dilatation of the organ, but also a marked hypertrophy and hyperplasia of the musculature. They found free hydrochloric acid constantly in the stomach.

Normally, when free hydrochloric acid exists in the stomach the duodenal flora is not abundant. In achylia gastrica the flora is changed and much increased. Berg and Jobling state that in chronic duodenal ileus, although there still is acid in the stomach, the number of aerobes and anaerobes in the duodenum increases markedly, however, without much inflammatory reaction in the walls. The predominating organism is not always the same. The point just below the obstruction is much poorer in a flora than that immediately above. After a time, however, the bacteria are reduced in numbers, even though the obstruction remains. Ivy remarks that the flora in the obstructed segment closely resembles that of the ileum and that toxin-producing bacteria are present.

The animals in which the obstruction has been produced, according to Berg and Jobling, exhibit a moderate secondary anæmia, but no chemical changes in the blood. Their dogs also showed a chronic interstitial nephritis. This is of interest in connection with a report by Brown, Eustermann, Hartmann and Rowntree concerning the appearance of toxic nephritis in duodenal obstruction. They believe that without the duodenal mucosa no toxic substance would be developed in high intestinal obstruction. Dragstedt has demonstrated that in duodenal obstruction toxic substances may be absorbed, which under normal conditions does not occur. Brown and others have shown that there are changes in the renal function, the urine contains albumin and casts, and the blood is low in chlorides, high in urea and creatinin. Tisdall observed that the calcium-sodium ration is unchanged, so there must also be a reduction in the calcium, although we have found no direct reference to this.

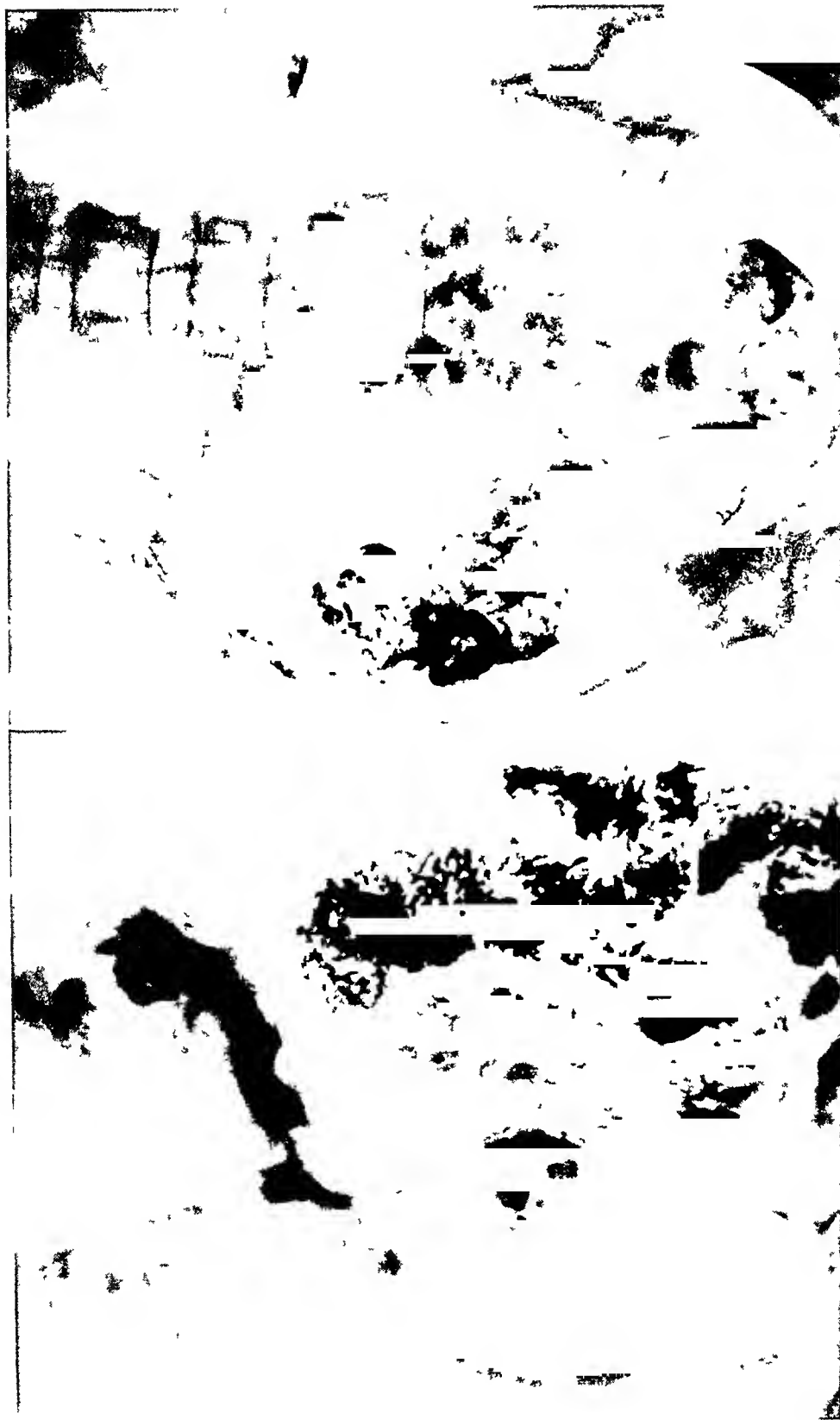


FIG 4

FIG 4—Megaduodenum

FIG 5

FIG 5—The same patient as in FIG 4 the exposure being made ten hours after the ingestion of the contrast medium

The symptoms of the disease entity are by no means accurate and definite, and the diagnosis is often a difficult one even after a careful roentgenological examination. Taylor observed that symptoms result when the obstruction is greater than peristaltic efficiency can easily overcome. The balance may gradually be lost with a slowly increasing symptom or be suddenly upset as a result of a prostrating injury or illness, when the viscus, becoming atonic, is no longer able to compensate the difficulty.

In many cases, according to Kellogg, symptoms appear only when the colon is filled and is dragged downward by the contents. Thus some of the symptoms will be characterized by a certain periodicity.

Most authors differentiate two types of subjective symptoms, the mechanical and the toxic. The latter consist in mental lassitude, fatigue, and headache, most commonly of the unilateral migraine type. An explanation of these toxic manifestations has been offered above in discussing absorption from the duodenum, and the bacterial flora. They are by no means constant, and assume a variety of form and intensity.

The mechanical symptoms have been classified by Wheelon as static or those following overdistention of the organ, and kinetic or those which are experienced when the organ exhibits abnormal motility. This rather fine differentiation he made by observing the symptoms when the patients were behind the fluoroscopical screen. In order to observe the effects of distending the normal duodenum, Ivy and others have swallowed small balloons and observed the sensations. Nausea, they state, is of most frequent occurrence. Pain is next in frequency. If the balloon is in the third part, the pain is referred to the epigastrium just above the umbilicus. As the balloon is withdrawn, the pain is felt on the right side just below the liver. Other symptoms which they noted were uneasiness, fainting, dragging and swaying sensations, dizziness, chilliness, and pallor. In some individuals a frontal headache set in.

Wheelon has characterized the sensations of fullness and localized heaviness as being the static type. Nausea, vomiting, pain, swaying and dragging sensations belong to the kinetic variety, with which Alvarez and Keeton agree.

Wolfer, on the other hand, is of the opinion that pain is due to pylorospasm. He states that in duodenal stasis the pyloric sphincter is tonic and prevents the regurgitation of duodenal contents into the stomach, which causes the pain or distress.

Duval describes attacks of migraine which coincide with the abdominal distress, and terminate with bilious vomiting and diarrhoea. Kellogg states that the vomiting of large quantities of bile may be the chief complaint when the obstruction is below the level of the ampulla. If the pylorus does not yield diarrhoea may take the place of the vomiting. Barker laid great stress on the examination of the vomitus, claiming that the presence of bile or pancreatic secretion was evidence that the regurgitation was from the duodenum, but Melchior has proven that biliary vomiting is not always seen in duodenal obstruction.

The symptom which is common to many of the patients is that they have immediate relief on vomiting, also that they often get relief by lying on their right side in the knee-chest position. The discomfort is sometimes relieved by pressure over the lower abdomen. Kellogg cites cases where the patients lie face downward with their fists pressed deeply into the abdomen. The patients may also complain of a transient jaundice or temporarily acholic stools. Burget and Graham have shown that the tonus and motility of the duodenum play fundamental rôles in the passage of bile from the biliary passages. Higgins believes that this may be due to direct pressure from the dilated duodenum.

The most characteristic elements in the symptomatology are the periodicity of the attacks, the fact that any food can bring them on, the association with headache, lassitude, *etc*, and the manner in which relief is obtained, namely, assuming a bizarre position rather than by medication.

The physical findings are, unfortunately, minimal. The patient is often of the asthenic type with a lax abdominal wall, and a ptotic habitus. The upper abdomen may be distended, and the umbilicus may appear to lie higher than normal. According to Hayes, percussion will give a tympanitic sound behind the right rectus muscle and just to the right of the pylorus. The pleximeter finger must be placed with sufficient pressure to diminish gastric and colonic tympany, bringing the examining finger closer to the duodenum.

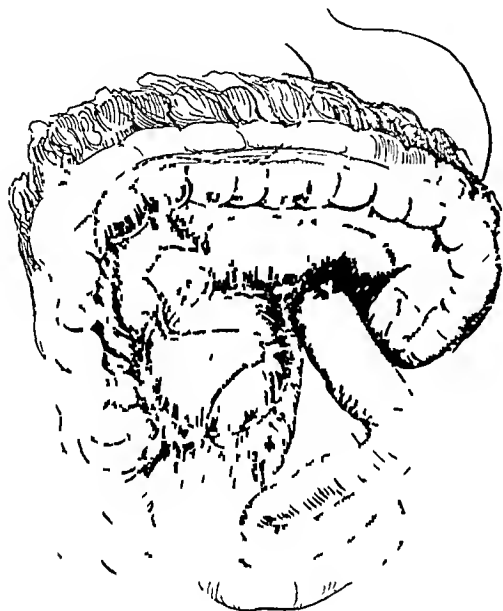


FIG 6

FIG 6—Sketch made during an operation. The hepatic flexure of the colon is held high, revealing the inferior duodenal flexure protruding through the transverse mesocolon. The proximal portion of the jejunum is also dilated. (Therefore a case of dynamic duodenal ileus.)



FIG 7

FIG 7—Sketch made during an operation showing a typical inframesocolic duodeno jejunostomy, combined with a Braun enteroenterostomy. The afferent jejunal loop has been closed. Same case as illustrated in Fig 6.

Pressure upward and backward beneath the transverse colon permits the duodenum to empty. Gas can then be felt or heard rushing into the jejunum, after which the sound will be relatively dull. Case has described succussion over the duodenum. Zade suggested the use of a stomach tube comparing the amount of water put into the stomach with the amount he could recover.

The diagnosis may be suggested by the clinical history and physical examination, but a roentgenological study is always required. It is made with the fluoroscopical screen, both in the erect and in the supine position. To observe the lower third part of the duodenum the patient is best placed in a semilateral position with his right side nearest the screen, thus projecting the stomach away from the duodenum. The differentiation from duodenal diverticula may be difficult, and then may be coincidental. To rule these out

pressure should be applied over the area, the contrast medium being pushed out of the duodenum and remaining in the diverticulum. Follow-up examinations several hours later may also be of value in clearing up this point.

From the Röntgen viewpoint the symptoms differ with respect to the part of the duodenum at which the stenosis occurs. Stenosis of the first part of the duodenum is clinically tantamount to pyloric obstruction. Case states that it cannot be diagnosed by the radiologist. The case in which the clinical signs are those of a pyloric stenosis, and the radiologist sees a deformed duodenal bulb, may, however, according to most observers be considered as a stenosis of the first part.

When the obstruction comes between the first and the second parts, the junction between these parts appears to be very high, according to Bell, Keith and Keith. They state that the duodenal bulb is usually long and dilated and frequently there is delay in expulsion of material from it. The bulb is often deformed, and may, according to Harris, assume an S-shaped curve. The stomach is dilated, its antrum lying to the right of the mid-line. The distorted bulb, however, has a different appearance than that seen with duodenal ulcer. Taylor is of the opinion that the hyperactivity of the stomach, combined with hypertonicity, later gives way to dilatation and ptosis. His belief is that many of the ptosed and fish-hook types of stomachs are the result of duodenal ileus, as operative relief from obstruction is followed by a rapid improvement in its size and position. Brinkner and Milch have reported that on relief of duodenal obstruction, gastric motility increases.

Stenosis between the second and third parts has been reported by McConnell and Hardman. The Röntgen findings are very similar to those in which the lesion is at the point where the mesenteric vessels cross the duodenum, and which will be discussed with the latter lesion. Kantor, however, makes the observation that if the second part is obstructed it will be pulled far to the right of its normal position.

In studying the obstruction of the inferior ramus, the size, the shape, the position, and the motility must be taken into consideration. As regards size there is some difference of opinion. Holmes and others are of the opinion that the organ does not necessarily appear dilated. We know that in most cases, however, a definite dilatation is present, and that experiments, such as those of Berg and Jobling, invariably show a similar result. The organ may assume huge proportions as may be seen in one of the accompanying illustrations.

The stomach in these cases is usually large and lying low. The duodenal bulb is wide and long. The contrast medium is then seen transversing and descending ramus and entering the third part. Here, according to Case, it is thrown back to the bulb by a powerful antiperistaltic action. "In the meantime, as a result of the gradual filling of the third portion, a peculiar shadow with convexity downward develops, which becomes larger and larger as the former movement is repeated." Soon rather violent waves of peristalsis will be seen and the barium will gather just orally to the point of obstruction. Then some of the barium will pass, and will be seen rapidly coursing through the remainder of the duodenum into the jejunum. Shattuck and Imboden have pointed out that the valvulæ connites are obliterated.

The reverse peristalsis in itself is not sufficient evidence for a diagnosis of duodenal ileus. Wheelon has observed reversed movements in people with a normal or even shortened gastric emptying time. Ivy states that they are due to reflexes from the celiac ganglion as well as from enteric reflexes, the same as when strong acid chyme has been injected into the duodenum. Reversed movements take place in vomiting, and in certain gall-bladder diseases. Henderson has reported antiperistalsis in 93 per cent of 102 patients infected with hookworms. Berg and Jobling have corroborated the work

of Wheelon and Thomas, and have found that the pyloric sphincter accommodates itself to the reversed peristalsis of the duodenum, relaxing during the negative antral phase and thus permitting regurgitation

Obstruction at the ligament of Treitz, according to Bell, Keith and Keith is exactly similar to the foregoing except for the point of stenosis, which is situated higher and more to the left, Shattuck and Imboden are of the opinion that this is the specific point of stenosis when one observes a writhing duodenum, and that the duodenojejunal angle is found to the right of the vertebrae. In the presence of the so-called Lane's gastrojejunal kink, the barium is to be seen swinging off to the right in a sharp angle to its former course

The diagnosis on the Rontgen findings is difficult, as may be imagined when the report of Kellogg and Kellogg shows that in only twelve of the forty-one cases coming to the operating table had the diagnosis been made on radiological examination

Diagnosis—The diagnosis is by no means a simple one as will be gathered from the above. A dilated duodenum is suspected in an asthenic individual, with lax abdominal musculature who complains of distress in the right hypochondrium. A careful history may bring out some of the characteristic symptoms alluded to, but the physical signs are the minimal value. Combining these with a complete roentgenological examination, including a study of the entire length of the duodenum, will in all probability make the diagnosis in a large number of cases, many of whom have been referred to the surgeon as obscure abdominal disease.

In the differential diagnosis gall-bladder disease and duodenal ulcer are most important. Acute appendicitis has been suspected in some. But it is more important that chronic duodenal ileus be placed in the differential diagnosis of the more common afflictions producing upper abdominal distress. It must be remembered that the chronic dynamic type is secondary to another pathological process, and so it may be a coincidental finding at operation and may be looked for. In Kellogg and Kellogg's series of forty-one cases the diagnosis was made in only twenty-three pre-operatively, but the alert surgeon looks for it and is rewarded.

Treatment—Once the diagnosis has been established without question, one has at his disposal a conservative course and an operative one.

The former is directed against ptosis, an attempt to relieve the stress on the mesenteric root. It is, therefore, of effect only in the cases of the arterio-mesenteric dynamic type, and at best only in a palliative sense. Holmes has expressed the opinion that the medical treatment will 'tax the skill and ingenuity of even the most accomplished physician.' He recommends prolonged bed rest and over-alimentation in the visceroptotic group. Others have recommended rest in a moderate Trendelenburg position and the wearing of abdominal binders and supports, thus combating the laxity of the abdominal musculature. Massage of the abdominal wall and postural exercises may prove valuable. Very frequent small feedings of a high caloric diet are advantageous, with a rigid care of the colon offsetting constipation with mild laxatives. The cure, however, is rarely destined to be permanent and surgical treatment will necessarily demand consideration.

DUODENAL ILEUS

Schoemaker has warned that many of the patients, especially those where we find an associated red membrane, are of a functional type, which, instead of being improved, are definitely set back by operative interference. Carslaw quotes Wilkie as saying that he had decided to set the indication more stringently than he had up to that time, reserving the operation to those cases where there is definite fluoroscopical evidence of duodenal dilatation.

Operative intervention should not be attempted before the patient's general condition has carefully been checked. Wolfer calls attention to the possibility of the patient's tolerating a rather high grade of obstruction and remaining in good physical condition. Yet a sudden anatomical accident may cause an acute exacerbation characterized by a severe toxæmia. Other cases are extremely ill and will tolerate but little surgical trauma. For this type of patient repeated duodenal lavage with the Levine or Rehfuess tube is of distinct value. To combat the toxæmia, the method of Dragstedt may be employed, which consists in the intravenous infusion of 500 cubic centimetres of Ronger's solution every four hours for twenty-four hours. Blood-chemistry studies previously referred to indicate that there is often a deficiency in the blood chlorides and possibly in the calcium. Haden and Orr, with this in mind, recommend the infusion of sodium chloride.

Little of anything has been remarked in the literature about examination of the renal function. Further investigation, by the methods now commonly in use, might prove profitable in the pre-operative period, and perhaps might save the patient from renal embarrassment during the post-operative days. Should jaundice be an accompanying factor, or gall-bladder disease be coincidental, the intravenous administration of glucose and calcium may be advantageous, perhaps combined with insulin, to stave off a hyperglycæmic reaction.

The surgical indication should be set with great care.

The choice of the operation is in many cases a difficult one and should be governed by the etiology. W. J. Mayo has said

"If the small bands of adhesions found in one case can be productive of harm to one patient, how can we expect another with similar symptoms to be benefited by the bands of adhesions which the surgeon forms to hold up a prolapsed organ? How much truth, and how much fancy, is wrapped up in the elucidation of this problem no one can say. Another group contends that they are all neurasthenics. That many patients have been benefited by operation is beyond doubt, yet if one were to take the case histories and successful reports of treatment by such mechanical therapy, and put them all in a hat to be picked out at random, one could not determine from the histories of the patients those who had been relieved of symptoms by operating for a mobile cæcum, for mobility of the colon, for prolapse of the stomach, or even for movable kidney."

In this statement, paradoxically Doctor Mayo emphasized the most vital point in determining the operative procedure. The symptoms are caused by the chronic ileus but the etiology of the obstruction is most complex and varied.

In many cases of the dynamic type it is possible, after recognition of the

etiological process, to correct it. With the tremendous variety of etiological processes, it is only natural that a wide variety of procedures has been recommended. The intrinsic lesions are usually treated by a nutrient jejunostomy or one of the short-circuiting operations. The latter will be discussed later.

In the extrinsic lesions the attack is to be directed against the cause, and, in selected cases, combined with a short-circuit operation. Gall-stones should be removed, bands of adhesions definitely producing a kink should be separated by sharp dissection. In diseases of the pancreas causing duodenal stenosis one of the short-circuiting operations must be resorted to. For obstruction in the first portion with gastropnoia, and with the superior angle normally placed, and free from pathology, except for kinking caused by the dragging of the stomach Beyer has recommended gastropexy. His enthusiastic reports were not corroborated by all workers, but there are also many reports of its application with good success. Kellogg and Kellogg say that it is particularly adapted when there is a roomy abdomen and a broad subcostal arch. Its advantages are that it is practically free from danger and is a simple procedure not likely to produce many adhesions.

The majority of operations in this group have been directed towards relief of the chronic arteriomesenteric type. Division of the duodenum, with an anastomosis between the cut ends anterior to the mesenteric root, has been suggested and, fortunately, promptly forgotten. Suture of the mesenteric root to the transverse mesocolon, Coffey's suturing of the omentum to the abdominal wall, taking a reef in the gastrocolic omentum, have been advised if the transverse colon is prolapsed.

When the ascending colon is held in a position of hyperfixation by the hepato-duodeno-colic band, Harris has advised that the band be divided and the hepatic flexure lowered. In the event of a cæcum mobile, with duodenal compression by the right colic artery, a right colpexy with plication of the cæcum is usually done. The latter procedure is designed to keep the cæcum from prolapsing into the pelvis. Bloodgood has reported a large series of cases in which he resected the right half of the colon and cæcum, combined with an ileocolostomy. Most authors, however, believe this operation too radical.

For the so-called duodenojejunal kink, several procedures have been advised. The ligament of Treitz may be stretched or divided, the latter procedure having been described by Freeman. The jejunum may be fixed to the transverse mesocolon, so that it sweeps off to the left.

The short-circuiting operations are used in the cases of the adynamic type, and in those cases where either the stenosis cannot be alleviated or only partly so. Gastroenterostomy of the posteromesocolic type has been done in many cases, with varying reports of success and failure. From a physiological standpoint, however, it is always most advantageous in a short-circuit procedure to have the anastomosis at the most dependent point of the dilated bowel. In the adynamic ileus and in the cases of obstruction at the mes-

enteric root, as well as at the gastrojejunal junction, the procedure of choice anatomically is the duodenojejunosomy

This operation, suggested by Barker in 1906 and Bloodgood in 1907, and first performed by Stavely one year later, Bartlett, in 1913, reported duodenojejunosomy using a Murphy button to complete the anastomosis. Ernst did the first successful operation on a congenital stenosis of the duodenum in an eleven-day-old child. Large series have been reported by Wilkie (sixty-four cases) and Kellogg and Kellogg (ninety-two cases). The operation is facilitated by the fact that the duodenum is dilated, and, therefore, usually more easily accessible. The transverse colon being raised, and some pressure applied from above, will bring the duodenum well into view as a bulge in the mesocolon. An anastomosis between a high loop of the jejunum is now made in the direction from lower right to upper left, which has been shown by Kraas to be the best to include the most dependent part of the duodenum. Schmieden and Kraas also point out that, in order to obviate any possibility of stasis in the proximal jejunal loop, it is best to also perform an entero-enterostomy, after the method of Braun.

In the case described recently by Beck, there was stasis in the ascending duodenal loop necessitating a second operation, at which time the duodenum just distal to the duodenojejunosomy was cut across, and both ends closed. This procedure, however, is not altogether free from danger, and in all probability will not become a method of choice.

Should chronic duodenal stasis be coincidental with a duodenal or gastric ulcer one is confronted with a somewhat difficult problem, for if one performs a gastroenterostomy or a gastric resection, there will be an accumulation of the duodenal pancreatic and biliary secretion in the dilated duodenal segment as well as back flow from the proximal jejunal segment. Several authors have advised combining the procedure chosen for treatment of the ulcer with a duodenojejunosomy. A case treated at this clinic with a gastric resection by the Polya Billroth II technic necessitated a subsequent duodenojejunosomy. Kraas has suggested that in these cases the possibility of the backing up of chyme into the duodenum can be avoided by making use of the Y-anastomosis suggested by Roux, in a termino-lateral gastrojejunosomy after resection. This might obviate such cases as described by Bloodgood in 1912.

For obstruction in the first part the treatment should be approximately the same as that for pyloric stenosis, removal of the cause, if possible, or pyloroplasty, gastroenterostomy or gastrectomy. For the comparatively rare lesion in the second portion Kellogg has suggested the use of a duodeno-duodenostomy.

The post-operative treatment should be carefully carried out. Wilkie has stressed the importance of postural therapy, *viz*, the foot of the bed elevated. In the immediate post-operative period the usual routine for gastric surgery should be followed. Later it is advisable that the patient wear a supporting belt, and be given exercises, *etc*, to strengthen the abdominal musculature.

Prognosis—The prognosis depends on the etiology. As in most cases a definite operative procedure can correct a mechanical defect, or, in the cases of the adynamic type, it is possible to aid the emptying of the dilated organ,

one is led to believe the results of operative interference should be most gratifying. However, the reports in the literature are not all over-optimistic. Kellogg and Kellogg, in thirty cases of duodenojejunostomy, report eighteen as cured, nine as improved markedly, three unimproved. Carslaw quotes Wilkie's fifty-six followed cases, with twenty-three cured and eleven much improved.

The gist of the discussion is that the indication for the operative interference will have to be set with the greatest of care, and only after a careful consideration of the etiology of the specific case. The operations are not entirely free from danger. Schoemaker has warned that in a certain percentage of the patients functional elements play an important role, and these people will not be benefited by any operative measures.

SUMMARY AND CONCLUSIONS

(1) There are two types of chronic duodenal ileus, one in which a definite mechanical obstruction to the passage of food through the duodenum may be found, and another where it is lacking.

(2) It has been suggested that a classification be adopted according to the etiology, grouping the mechanical obstructions under the term dynamic ileus, and the functional obstructions as adynamic ileus. Under these two headings the individual causes are to be listed.

(3) The occurrence of such cases is probably greater than clinical experience would indicate, but because of the variety in appearance, the lack of physical signs, difficulty in roentgenological demonstrations, the diagnosis, it is often missed. Probably another factor is that it is not thought of or looked for, either in fluoroscopical examination of the stomach or at operation on the stomach or neighboring viscera.

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OPERATIVE MORTALITY IN INTESTINAL OBSTRUCTION

BY FREDERICK CHRISTOPHER, M D , AND W KENNETH JENNINGS, M D
OF EVANSTON, ILL

FROM THE EVANSTON HOSPITAL AND THE NORTHWESTERN UNIVERSITY MEDICAL SCHOOL

No APOLOGY need be offered for further study of intestinal obstruction. Not only is the operative mortality extremely high (in the neighborhood of 45 per cent), but moreover, there seems to have been no improvement in this mortality in the last thirty-five years. Although the statistics of various clinics are not always strictly comparable because of the method of selection of cases, a consideration of these figures gives an excellent idea of the gross mortality. Table I shows a mortality in 2,345 collected cases of 46.5 per cent. This number includes 1,000 cases collected by Gibson⁶ from the literature of 1888 to 1898 which have a mortality of 43.2 per cent. Recently McIver⁷ reported 335 cases from the Massachusetts General Hospital with a mortality of but 31 per cent. This series, however, apparently does not include paralytic ileus. Other figures are Brill,⁸ 124 cases with 36 per cent mortality, Tuttle,⁹ 150 cases with 50 per cent mortality, Souttar,¹⁰ 3,064 cases with only 32 per cent mortality and Braun and Weitman¹¹ 379 cases with 39 per cent mortality.

TABLE I

Comparative operative mortality in intestinal obstruction at different clinics

Clinic	Cases	Mortality
EVANSTON HOSPITAL (10-year period) Collected by Christopher, F , and Jennings, W K	127	44.9%
JOHNS HOPKINS HOSPITAL (10-year period), Finney, J M T ¹	217	35.0%
NEW YORK HOSPITAL (17-year period), Cornell, N W ²	218	58.4%
LOS ANGELES COUNTY GENERAL HOSPITAL (5-year period), Vidgoff, I J ³	266	45.9%
CHARITY HOSPITAL AND TOWN INFIRMARY, NEW ORLEANS (5-year period), Miller, C Jeff ⁴	342	60.0%
LEBANON HOSPITAL, NEW YORK (10-year period), Koslin, I I ⁵	175	40.0%
VARIOUS HOSPITALS Collected from the literature 1888-1898 by Charles L. Gibson ⁶	1,000	43.2%
Total	2,345	46.5%

The present study is based upon 127 proved cases of intestinal obstruction occurring at the Evanston Hospital in the ten-year period from 1922 to 1932. These cases were operated upon by twenty visiting surgeons of whom

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five attended 79 per cent of the cases The relative operative mortality of the five men having the most cases is of interest and is shown in Table II.

TABLE II

Surgeon	Cases	Mortality
A	32	25%
B	20	45%
C	16	50%
D	14	43%
E	13	84%
15 surgeons	25	40%

The commonest etiology at the Evanston Hospital was adhesions and following this in order of frequency came neoplasms, volvulus, paralytic ileus, incarcerated hernia, intussusception, mesenteric thrombosis, and miscellaneous This is somewhat at variance with the incidence of etiology shown in 1,332 cases collected from the recent literature and including the Evanston Hospital cases In this series (Table III) the etiology in order of frequency was adhesions, hernia, miscellaneous, intussusception, malignancy and volvulus In McIver's series strangulated external hernia occurred more frequently than obstruction due to adhesions ⁷

TABLE III

Incidence of etiology of intestinal obstruction in different clinics

Clinic	Adhe- sions	Hernia	Intusus- ception	Malg- nancy	Volvu- lus	Miscel- laneous
Evanston Hospital	46	9	9	32	14	17
Johns Hopkins Hospital ¹	128	50	8	26	8	25
New York Hospital ²	110	10	36	16	16	47
Los Angeles County General Hospital ³	170	49	11	22	4	8
Charity Hospital and Tourn Infirmary ⁴	98	96	42	17	34	55
Lebanon Hospital ⁵	26	60	34	10	9	30
Total	578	274	140	123	85	182

The mortality according to etiology was studied in the Evanston Hospital cases and is shown in Table IV The highest mortality was in mesenteric

TABLE IV

Operative mortality in intestinal obstruction at the Evanston Hospital

Cause of Obstruction	Cases	Deaths	Mortality
Adhesions	46	13	28 2%
Neoplasms	32	12	37 5%
Volvulus	14	7	50 0%
Paralytic Ileus	12	11	83 3%
Incarcerated Hernia	9	7	77 7%
Intussusception	9	2	22 2%
Mesenteric Thrombosis	3	3	100 0%
Miscellaneous	2	2	100 0%
Total	127	57	44 9%

TABLE V

Relationship of operative mortality to etiology at different clinics

Clinic	Adhesions		Hernia		Intussusception		Malignancy		Volvulus		Miscellaneous	
	Cases	Mort	Cases	Mort	Cases	Mort	Cases	Mort	Cases	Mort	Cases	Mort
Evanston Hospital	46	28 2%	9	77 7%	9	22 2%	32	37 5%	14	50 0%	17	94 1%
⁸³ ⁸⁴ New York Hospital ²	105	41 8%	10	30 0%	36	47 2%	16	75 0%	13	46 1%	38	65 8%
Los Angeles County General Hospital ³	170	37 6%	49	60 0%	11	66 0%	22	68 0%	4	75 0%	8	12 5%
Charity Hospital and Tourn Infirmary ⁴	98	58 1%	96	61 5%	42	52 4%	17	88 2%	34	58 8%	55	70 9%
Lebanon Hospital, New York ⁵	26	34 6%	66	25 7%	34	32 3%	10	40 0%	9	44 4%	30	83 3%
Total	445	42 0%	230	50 0%	132	44 7%	97	59 8%	74	54 0%	148	71 6%

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thrombosis and paralytic ileus and the lowest was in intussusception and the cases due to adhesions. In Table V is tabulated a series of cases from recently published statistics at representative clinics.

From Table V it will be noted that the percentage of mortality at the Evanston Hospital due to adhesions, intussusceptions, malignancy and volvulus was less than the average. The operative mortality in intussusception was 22.2 per cent which compares very favorably with the general average of 44.7 per cent. The mortality in the adhesions cases was 28.2 per cent as compared to the average of 42.0 per cent. On the other hand, the showing in hernia and in the miscellaneous cases was poorer than the average. Of interest in this connection was the fact that in McIver's⁷ series the mortality for strangulated external hernias was but 18 per cent in 147 cases.

Mere speed of operation did not seem to have a bearing in the Evanston Hospital Cases (Table VI). It is quite possible, however, that the cases

TABLE VI

Relationship of operating time to mortality in 109 cases of intestinal obstruction (all causes)

Operating Time	Cases	Deaths	Mortality
Under 30 minutes	14	6	42.8%
30 to 60 minutes	51	17	33.3%
Over 60 minutes	44	17	38.6%

in the poorest condition were operated upon most quickly. In the forty-six cases of intestinal obstruction due to adhesions there were previous operations in thirty-four cases (Table VII).

TABLE VII

Types of previous operations noted in forty-six cases of intestinal obstruction due to adhesions

A Single operations

(1) Appendectomy	13
(2) Pelvic operations	9
(3) "Laparotomy"	3
(4) Cholecystectomy	2
(5) Herniotomy	2
(6) Gastroenterostomy	1
(7) For intestinal obstruction	1

B Two operations

(most recent noted first)

(1) Hysterectomy, appendectomy	1
(2) Herniotomy, appendectomy	1
(3) Pelvic operation, "laparotomy"	1

C No operations

12

Appendectomies and pelvic operations were the commonest offenders. It is of interest to note in this connection that 68 per cent of Vidgoff's³ cases of all types of intestinal obstruction had had previous operations. In seventy-

two of his cases there were mid-line incisions and in 62 per cent of these there had been operations upon the female pelvic organs. Twenty-four and two-tenths per cent of Miller's¹ cases and 40.0 per cent of Finney's¹ had had previous operations.

The earlier the diagnosis is made and operation carried out the lower the mortality. This statement is graphically borne out in Tables VIII and IX.

TABLE VIII

Relationship of operative mortality to the duration of symptoms before operation in cases of obstruction due to adhesions

Duration of Symptoms before Operation	Cases	Deaths	Mortality
Under 24 hours	4	0	00.0%
24 to 48 hours	10	3	30.0%
Over 48 hours	25	9	36.0%
Not given	7	1	14.4%

TABLE IX

Relationship of operative mortality to duration of symptoms before operation in cases of intestinal obstruction due to volvulus

Duration of Symptoms before Operation	Cases	Deaths	Mortality
Less than 24 hours	2	0	00.0%
24 to 48 hours	6	2	33.3%
Over 48 hours	5	4	80.0%
Not stated	1	1	100.0%

The mortality in cases of intestinal obstruction due to external hernia was 66.6 per cent and in internal hernia 100.0 per cent. Death followed all three of the cases due to incisional hernias. (Table X.)

TABLE X

Types of hernias causing intestinal obstruction

A	External	6	Deaths	4	Mortality	66.6%
	(a) inguinal	2	Deaths	1	Mortality	50.0%
	(b) femoral	1	Deaths	0	Mortality	00.0%
	(c) incisional	3	Deaths	3	Mortality	100.0%
B	Internal	3	Deaths	3	Mortality	100.0%
	(a) ileum through omentum (previous hysterectomy and appendectomy)					
	(b) ileum through mesentery of a Meckel's diverticulum					
	(c) not stated					

An attempt is made to appraise the value of the various operative procedures in Tables XI, XII and XIII. The case for enterostomy is strengthened by Table XI which gives an operative mortality of 33.0 per cent. In the cases due to volvulus (Table XIII) the mortality was less where enterostomy was not done. In the intussusception cases (Table XII) the mortality was far less where the bowel was not opened.

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TABLE XI

Relationship of operative mortality to operative procedures in cases of intestinal obstruction due to neoplasms

Type of Operation	Cases	Deaths	Mortality
Resection	5	2	40 0%
Resection and enterostomy	4	2	50 0%
Enterostomy only	18	6	33 0%
Enteroenterostomy	2	0	00 0%
Exploratory only	2	1	50 0%
No operation	1	1	100 0%

TABLE XII

Relationship of type of operation to mortality in cases of intestinal obstruction due to intussusception

Type of Operation	Cases	Deaths	Mortality
Resection	2	1	50 0%
Reduction of intussusception	7	1	14 3%

TABLE XIII

Relationship of operative technique to operative mortality in cases of intestinal obstruction due to volvulus

Procedure	Cases	Deaths	Mortality
Enterostomy	2	2	100 0%
No enterostomy	12	5	41 6%

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SARCOMATOID FIBROMA OF THE SKIN

(PROGRESSIVE AND RECURRING DERMATOFIBROMA)

BY PAUL E McMASTER, M D

OF CHICAGO, ILL

FROM THE DEPARTMENT OF SURGERY OF THE UNIVERSITY OF CHICAGO

SARCOMATA of the skin, although relatively rare, has been recognized for many years. However, in 1924, Darier⁴ described a distinct, separate, relatively benign, but progressive and recurrent neoplasm of the skin under the title, "Progressive and Recurring Dermatofibroma, or Fibrosarcoma of the Skin." Since that time several similar cases have been studied and reported. One additional case will be presented in this article, making a total of thirty-nine such cases collected from the literature.

The distinguishing characteristics of this skin tumor are: Single origin (more rarely origin from two or three locations), usually located on the trunk, firm, painless, nodular in character in the early stage, becoming later, protruding, pedunculated or cauliflower-like masses, the growth being away from the body and remaining freely movable over the deep fascial layers, bluish-red discoloration of the overlying skin, histologically somewhat similar to fibrosarcoma, but invading only the adipose tissue, and not the deep fascial layers, never metastasizing but recurrent if inadequately excised.

Following Darier's description of "Progressive and Recurring Fibromata, or Fibrosarcoma of the Skin," in 1924, Hoffmann,⁷ one year later, made studies of similar cases and called the condition "Dermatofibrosarcoma Protuberans." Still later, in 1929, Mosto¹³ suggested the title "Dermatoneuroma, or Dermatoschwannoma."

Studies of this condition have been made from a review of the literature (see Table) and the case to be reported.

TABLE OF PUBLISHED CASES

CASE I—Doctor Kartscher²⁰ male, seventy-one years old. Duration of disease—sixty years. A protruding nodular mass, the size of an orange, with an ulcerated and bleeding surface located on the abdomen. No pain. Recurred each time after three excisions. Died of pneumonia.

CASE II—Doctor Kartscher male, fifty-five years old. Duration of disease—six years. Orange sized tumor, nodular and protruding with a pale red and slightly eroded surface located on abdomen. No pain. History of trauma. Excised but recurred one and one-half years later.

CASE III—Doctor Kartscher female, fifty-five years old. Duration of disease—seven years. Several nodules protruding from a plaque with reddish overlying skin and located on abdomen. No pain. History of trauma. Excised but length of cure not stated.

CASE IV—Doctor Pfeiffer²⁰ female, sixty-one years old. Duration of disease—thirty-one years. Protruding nodular mass, size of a fist, located on abdomen. Some discomfort. Excised but length of cure not stated.

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CASE V—Doctor Pfeiffer male, twenty-two years old Duration of disease—fifteen years Protruding and nodular mass located on abdomen with reddish overlying skin No pain Excised three times after three recurrences

CASE VI—Doctor Pfeiffer female, fifty-three years old Duration of disease—two years No pain Protruding and nodular mass with an ulcerated surface located on abdomen History of trauma Excised but length of cure not stated

CASE VII—Doctor Coenen⁷ female, sixty-one years old Duration of disease—ten years Small nodule on shoulder Large ulcerated nodular mass located on thigh No pain Excision and no recurrence after three years

CASE VIII—Doctor Coenen male, fifty-three years old Duration of disease—twenty-eight years Nodular mass somewhat protruding located on abdomen and covered with bluish red overlying skin No pain Excised and no recurrence after eight years

CASE IX—Doctor Arzt¹ female, forty-five years old Duration of disease—fifteen years An ulcerated, bleeding, protruding and nodular mass located on left breast Regional lymphadenitis Excised but length of cure not stated

CASE X—Doctors Kuznitzsky and Grabisch⁹ female, forty-three years old Duration of disease—twenty-five years Ulcerated nodular mass five centimetres in diameter located in region of right clavicle No pain Excised After five years two small nodules recurred

CASE XI—Doctors Kuznitzsky and Grabisch female, twenty-eight years old Duration of disease—fifteen years Several pea to walnut-sized nodules protruding from region of breast with bluish red overlying skin No pain Pectoral muscle adherent in tumor History of trauma Excised but length of cure not stated

CASE XII—Doctors Kuznitzsky and Grabisch male, twenty-two years old Duration of disease—fifteen years Nodular mass four centimetres in diameter located on left chest Overlying skin dark red Excised No recurrence after two years

CASE XIII—Doctor Darier⁵ male, forty-eight years old Duration of disease—three years Nodular and protruding mass the size of hen's egg located on abdomen No pain Overlying skin purple Treatment—Diathermy, radiotherapy, thermocautery and excision Recurred after the first three Shortly after excision patient died of pneumonia

CASE XIV—Doctor Darier male, sixty-seven years old Duration of disease—forty-two years Nodular protruding mass, the size of palm of hand, located in inguinal region Overlying skin reddish purple No pain Excision, with radiotherapy and diathermy, four times after recurrences Death from gangrene of leg

CASE XV—Doctor Darier female, forty-three years old Duration of disease—four years Nodular tumor mass size of palm of hand located in left lower abdominal region Overlying skin dark red No pain Excised Length of cure not stated

CASE XVI—Doctor Darier male, forty-two years old Duration of disease—nine years Protruding nodular mass 10 by 20 centimetres located on abdomen Overlying skin red No pain Treatment—X-ray Regressed temporarily but recurred

CASE XVII—Doctor Lutz¹¹ male thirty-two years old Duration of disease—nine years Nodular protruding mass 9 by 12 centimetres in left loin Overlying skin rose to livid No pain Excised Length of cure not stated

CASE XVIII—Doctor Weidman¹⁵ male, twenty years old Duration of disease—seven years Nodular mass size of silver dollar located on upper thigh Overlying skin dark red No pain X-ray treatment and excision Length of cure not stated

CASE XIX—Doctor Hoffmann⁷ male, fifty-seven years old Duration of disease—twelve years Protruding nodular mass size of fist located on right buttock Bled once after trauma Overlying skin reddish No pain Excised No recurrence after two and one-half years

CASE XX—Doctor Hoffmann male, sixty years old Duration of disease—fifty years Ulcerated and bleeding nodular mass size of an apple on flexor surface of right wrist Slight pain History of trauma Excised No recurrence after one year

CASE XXI—Doctor Hoffmann male forty-nine years old Duration of disease—three years Protruding nodular mass the size of an apple in the subscapular region Overlying skin blue-red Excised No recurrence after one year

CASE XXII—Doctor Scomazzoni¹⁴ male forty-three years old Duration of disease—twenty-three years Several protruding nodules on plaque located on right shoulder Overlying skin red to purple Treatment—X-ray Some improvement then progression of disease

CASE XXIII—Doctor Darier male, forty-nine years old Duration of disease—twenty-five years Protruding walnut sized mass located in pectoral region Overlying skin violaceous No pain Treatment—Radium, no cure Excised No recurrence after two years

CASE XXIV—Doctor Seneor et al¹⁵ female, forty-nine years old Duration of disease—twelve years Several protruding nodular masses hazel nut to hen's egg in size on lower right abdomen Overlying skin ulcerated Treatment—X-ray and three excisions No recurrences after last excision, at two months

CASE XXV—Doctor Seneor, et al female, fifty-nine years old Duration of disease—one year Protruding and nodular mass on upper outer chest wall Overlying skin dead glistening white, partly ulcerated and bleeding Excised No recurrence after two years

CASE XXVI—Doctor Kiess⁹ male, twenty-eight years old Duration of disease—two years Nodular and protruding mass 10 by 12 centimetres in suprapubic region Overlying skin telangiectatic Excised No recurrence after nine months

CASE XXVII—Doctor Willis¹⁰ female, forty-five years old Duration of disease—twenty-four years Nodular mass three centimetres in diameter on radial side of wrist Overlying skin reddish-purple No pain History of trauma Excised twice, once for recurrence Length of cure not stated

CASE XXVIII—Doctor Willis female, fifty years old Duration of disease—one year Nodular tumors left breast and back (Twelve years previously these had been excised but had recurred one year before admission)

CASE XXIX—Doctor Willis Author gives no case history except there were nodular elevations ranging from one to five centimetres in diameter Diagnosis made microscopically

CASE XXX—Doctor Willis male forty years old Duration of disease not stated Ten nodules from two to ten centimetres in diameter located on abdomen Overlying skin whitish Tumors removed from abdominal wall eight years before but there was recurrence No treatment given

CASE XXXI—Doctor Usher¹⁷ male, thirty-three years old Duration of disease—eight years Protruding and nodular mass in umbilical region Overlying skin reddened No pain Excised No recurrence after five months

CASE XXXII—Doctor Usher female, thirty-five years old Duration of disease—fifteen years Nodular protruding masses on right thigh abdomen and back Inguinal lymphadenitis from superficial infection of thigh lesion Overlying skin bluish-red Biopsy done X-ray treatment caused a regression

CASE XXXIII—Doctor Lapa¹⁰ female fifty years old Duration of disease—five years Protruding nodular mass 6 by 11 centimetres in inguinal region Overlying skin dark red History of trauma Excision Length of cure not stated

CASE XXXIV—Doctor Mosto¹³ male, thirty-two years old Duration of disease—twenty years Five nodular and protruding tumors in inguinal region Overlying skin slightly eroded and cyanotic Biopsy Treatment or result not mentioned

CASE XXXV—Doctor Scolari¹¹ female, forty-five years old Duration of disease—ten years Protruding chicken egg sized nodule on abdomen Overlying skin reddened and partly ulcerated Excised Recurred in one year

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CASE XXXVI—Doctor Bezecky—male, forty-eight years old Duration of disease—thirty-eight years Many protruding nodules on chest and abdomen Overlying skin blue-red and ulcerated Excised but recurred in five months

CASE XXXVII—Doctor Bezecky—female, thirty-one years old Duration of disease—fifteen years Plaque fifteen centimetres in diameter with protruding nodules located on back Overlying skin red Excised radically Length of cure not stated

CASE XXXVIII—Doctor Bezecky—female, thirty-five years old Duration of disease—three years Protruding and nodular mass on abdomen and one on back Overlying skin red Excised Length of cure not stated

CASE REPORT—White male, aged sixty-six, noticed two years before entering the University of Chicago Clinics a small, firm painless lump in the upper right abdominal wall This remained the size of a small cherry until two months before examination, at which time it commenced to increase fairly rapidly in size The overlying skin was not discolored at first, but became dull red There was no pain at any time, but the patient was conscious of the mass when he wore tight clothing His general health was excellent The patient was a healthy white male who presented the following positive findings A few carious teeth, right inguinal hernia and a walnut-sized mass in the upper right abdominal wall The skin overlying the mass was a dull reddish color The mass protruded slightly and was composed of a nodule about three centimetres in diameter and a smaller nodule attached on the medial side, less than one centimetre in diameter The whole mass was firm, not tender, but freely movable over the underlying fascia There was no regional lymphadenopathy and no other skin lesions Wassermann was negative

The mass was widely excised, taking considerable normal tissue on all sides

There has been no recurrence after eighteen months

Pathological studies of this tumor revealed the following *Gross*—The mass was composed of two firm nodules, the larger measured three by two by two centimetres, and the smaller, which was attached to the larger, measured one centimetre in diameter The growth was located in the corium and was quite firmly adherent to the overlying skin but not attached to the deep fascia Increased resistance over the surrounding tissues was noted in cutting the nodules, and the surfaces made by cutting were grayish-white and traversed by a network of fine, interlacing fibrous strands The tumor appeared to be definitely delimited from the subcutaneous structure, but in attempting to remove it, fine finger-like projections were seen to extend into the surrounding tissues These were easily broken The overlying skin was intact and discolored bluish-red, being a darker color on the papillary side The epidermis and tumor were separable

Microscopical—The growth was situated in the corium and extended into the papillary layer of the skin It penetrated the deeper tissues in finger-like projections which gradually frayed out in the adipose tissue (Fig 1) The cells composing the tumor were mostly fusiform, quite densely packed and arranged in whirls and radiating from centre points (Fig 2) In the peripheral portions the cells were less densely packed and gradually changed into normal tissue Blood-vessels were present, but more numerous in the peripheral portions There was no thrombosis and some of the vascular spaces contained red blood-cells The growth extended into the papillary layer, which was somewhat flattened, but the neoplastic cells were less dense here than deeper One section showed skin glands in the tumor near the periphery

A study of the tumor under high-power magnification revealed fusiform and ovoid-shaped cells containing dark-stained nuclei which were elongated, spindle-shaped, ovoid and irregular (Fig 3) There was a moderate amount of agranular, pale-staining cytoplasm Two mitotic figures were found after a careful search was made A delicate stroma of collagenic fibres was seen The larger blood-vessels were lined by flattened endothelial cells but in the tumor proper, smaller vascular spaces appeared to be, at least partly, lined by tumor cells Red blood-cells were present in some of the spaces

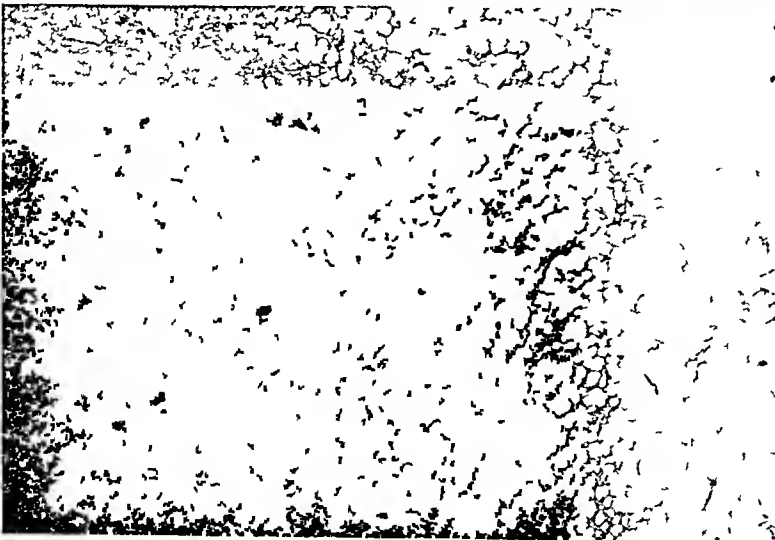


Fig 1—Low power view showing the tumor process invading into the deeper adipose tissue, where it frays out. There is no encapsulation.

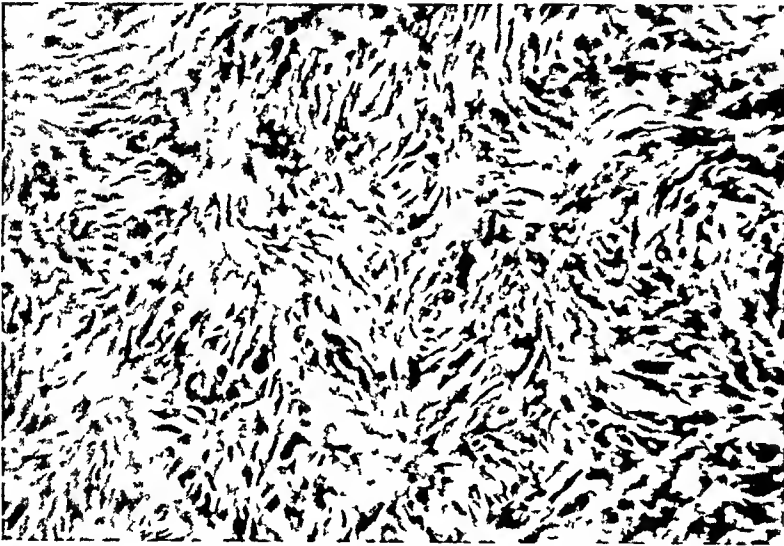


Fig 2—More detailed study showing the sarcomatoid arrangement of the cells.



Fig 3—A few isolated cells under high power magnification showing their spindle, elongated and ovoid character.

The overlying epidermis was slightly flattened but intact. In two sections of several taken through the skin and underlying tumor there appeared a larger number of chromatophores both in the cutis and epidermis than normal, but these were located in the more peripheral portions where the tumor cells had not invaded the papillary layer. The chromatophores apparently had no relationship to the tumor as melanism was not found in the neoplastic cells. Extravasated red blood-cells were found in the papillary layer (accounting for the skin discoloration).

A Mallory connective-tissue stain showed a fine collagenic stroma throughout the tumor. Weigert's elastic tissue stain revealed an absence of this tissue from the tumor proper, although there was some present in the peripheral portions as well as in some of the larger blood-vessels. No atrophic or degenerated nerve fibres could be demonstrated in the tumor with a Freeman stain. A fat stain showed the tumor cells extending into the adipose tissue.

Studies of the reported cases and the one above reveal that the exact etiology of this condition is unknown. Trauma preceded only eight of the cases. Heredity played no part. Only one case was reported with a positive Wassermann, which, after vigorous anti-luetic treatment, showed no appreciable improvement in the neoplastic process.

The average age onset was thirty. The oldest age of onset was sixty-four, while the youngest was seven. The majority of cases occurred between the ages of twenty and forty-five. Males and females were about equally affected and the duration of the disease ranged from one to sixty years, the average duration being about sixteen years. General health of the patients was excellent.

The significance of an abnormal number of chromatophores, which were seen in the case reported here, as an etiological factor is conjectural. It does not seem logical to assume that these tumors are of naevus origin, as melanism has not been reported by previous observers and was not found in the tumor cells of this case. In a study of this subject Masson's¹² work on the origin of naevi should be consulted, in which he states naevi are of neurogenic origin.

The patients first noticed a small, painless, firm nodule in the skin, most frequently located on the abdomen, less often in the inguinal and chest regions and rarely on the extremities and back. No cases were reported with lesions on the head or below the thighs. The overlying skin at first is usually normal in color. Gradually the nodule increases in size, often by the coalescence of new nodules, forming a plaque, or "mother tumor," ranging in size from a few centimetres to as large as the palm of a man's hand. These plaques are not as a rule elevated but occasionally may protrude slightly. Nodular excrescences and protuberances develop on the plaque, ranging in size from cherries to large apples. These may be single or multiple, small or large, protruding nodules, and even large pedunculated, or cauliflower-like masses. The plaque may take several years to develop, while the nodular outgrowths are more apt to increase rapidly in size within just a few months. The characteristic feature, however, is that they grow outward, but never grow inward to invade the deeper fascial layers. There was

one exception to this, Kuznitzsky's⁹ second case involved the underlying pectoralis muscle

From the start the tumor masses are firm, painless, well defined, and during the entire course remain freely movable over the underlying deep fascia. They are adherent to the overlying epidermis.

Spontaneous regression in size of some of the nodules has been noted in a few cases. Also some softening has been noted in the nodules most likely due to hæmorrhage from trauma, in the tumor substance.

Although normal in color at first, the overlying skin gradually becomes discolored, becoming dark bluish-red. At times however, especially in the larger ones, the surface of the protruding tumors becomes eroded, with resultant ulceration. This is the result of mechanical rubbing of clothes and trauma to the surface. Following the appearance of an erosion, spontaneous hæmorrhage of varying amounts may occur also tumor tissue may protrude through the erosion, presenting a dark red vegetating appearance. Secondary infection may supervene on an eroded surface and crusting of the lesion occur.

Regional lymphadenitis occurred in two cases but this was an inflammatory reaction following the infection of the tumor and not a metastatic invasion. The coincident or subsequent appearance of tumors of a similar nature on other parts of the body has caused some speculation as to skin metastasis, especially as in Usher's¹⁷ second case the patient had a lesion on the thigh, abdomen and back, respectively. But from the lack of regional gland, skeletal or visceral metastases and the usual unilateral location of these tumors, the evidence points more to separate local stimuli producing the respective conditions than to metastases.

Pain is not present at any stage. Discomfort may follow the protruding tumors and the discharge, or varying amount of hæmorrhage may cause some inconvenience. The general health of the patients is unaffected by the growths.

Pathological studies of the reported cases are quite characteristic. On gross examination one or several nodules are seen, usually the latter. The size may vary from one or two to several centimetres in diameter. The tumors are located in the corium. The nodules cut with marked resistance and show the tumor to be firm, grayish-white and adherent to the overlying skin. The cut surfaces are traversed by a web-work of interlacing strands. The tumor appears to be definitely delimited but in attempting to remove it from its bed, fine finger-like projections are seen to extend into the surrounding tissue. (This explains the recurrence after incomplete excision.) These extensions are easily broken. The tumor is quite firmly adherent to the overlying epidermis but can be separated from it. The overlying skin is usually discolored bluish-red and is smooth, often thinned and at times its continuity is interrupted by surface erosions. This occurred in more than one-fourth of the reported cases. If this occurs the tumor may protrude through the skin in a dark hæmorrhagic vegetating mass. Also, the under-

lying tumor may be the seat of a varying amount of hæmorrhage, thus changing the normal grayish-white color to a dark red hæmorrhagic appearance. With the skin intact a noticeable feature is the darker appearance of the papillary side, compared to the superficial surface of the epidermis. In only one case was the tumor attached to deeper fascia or muscle. (See Kuznitzsky's second case.)

Microscopical studies show the tumor to be situated in the corium extending into the papillary layer. The tumor cells penetrate into the subcutaneous adipose tissue in finger-like projections, gradually fraying out as one looks into the deeper portions of the underlying fatty tissue, illustrated in Fig. 1. Under low magnification the tumor is composed of densely packed fusiform cells, arranged in whorls and bundles, as seen in Fig. 2. The cells are less densely packed in the peripheral portions of the growth and gradually fade into normal tissue. Blood-vessels are present, but more numerous in the peripheral portions. There is no thrombosis of the vessels and red blood-cells are present in some of the spaces.

The tumor growth extends into the papillary layer, which in some regions remains unchanged, in others flattened. The tumor cells in the papillary layer are as a rule less densely packed than deeper. The epithelium in some regions is thinned. When the tumor protrudes slightly, the epithelium is, as a rule, not thinned, but in the larger protruding masses the overlying epithelium is apt to be flattened.

Normal glands of the skin are usually absent from the tumor proper, but were occasionally noted.

A detailed study of the fusiform cells reveals a dark-staining nucleus, elongated, spindle-shaped, ovoid and irregular. There is a moderate amount of agranular, pale-staining cytoplasm. An occasional mitotic figure is seen, but they are not numerous.

The vascular spaces are for the most part lined by flattened endothelial cells and occasionally contain red blood-cells. A few of the smaller vascular spaces appear to be at least partly lined by tumor cells.

A fine collagenic stroma is seen between the cells. This is well demonstrated by Mallory's connective-tissue stain. Weigert's elastic-tissue stain shows this tissue practically absent in the tumor proper, but present in increasing amounts as one passes to the more peripheral parts of the tumor. It is also present in the larger blood-vessel walls. Sections taken through the older, less actively growing parts of the tumor reveal similar but less densely packed cells, less hyperchromatic nuclei and considerably more collagenic matrix.

Areas of myxomatous swelling have been described but this is not a constant finding.

Complete surgical excision including a fairly wide zone of healthy skin and subcutaneous tissue has proved the only method of complete cure. Various other types of treatment, such as radiotherapy, thermocautery, diathermy and galvano-therapy, have not resulted in cures. The use of radiotherapy has

caused some regression in the nodules but recurrences have occurred. Incomplete surgical excision, leaving behind some of the finger-like projections into the subcutaneous tissue, have resulted in quite rapid recurrences, which is one of the characteristics of the tumor. Hence, for permanent cure, complete surgical excision followed by roentgenotherapy to inactivate or destroy any of the tumor tissue remaining is the treatment of choice.

Since these tumors were first described seven years ago, a number of cases have been recognized and reported. Hence the author believes with other writers that the condition is probably fairly common. Similar tumors have likely been removed and a pathological report of "fibrosarcoma" or simply "fibroma" has been returned, without recognizing the true condition. Hertzler⁶ states that he has had twenty-two fibrosarcomatous tumors of the skin of the trunk in twenty-five years. However, as he stated, a capsule is present and metastases occur, the classification of these tumors under the heading of this paper is doubtful.

The author agrees with Scolari¹⁴ that the title Dermatoneuroma, or Dermatoschwannoma should be rejected, at least until further evidence is offered in support of a neurogenic origin. In support of a fibroblastic origin, the tumors show considerable collagen formation with Mallory connective-tissue stain.

The term fibromata does not seem adequate to describe these tumors, for they are not encapsulated, do invade the adipose tissue, and tend to recur following incomplete excision. On the other hand, fibrosarcoma in the usual interpretation suggests a malignant tumor which grows rapidly, invading the deep structures, producing metastases and often death. Hence, because of these reasons and histologically showing sarcomatoid tendencies, but not the malignancy of a fibrosarcoma, the title "Sarcomatoid Fibroma of the Skin," is suggested.

SUMMARY

(1) "Sarcomatoid Fibroma of the Skin," being sufficiently descriptive and not misleading, is suggested as the title for this distinct clinical and pathological entity.

(2) The condition is slowly progressive, not fatal, but recurrent if inadequately excised.

(3) Complete and wide surgical excision, followed by roentgenotherapy, is the treatment of choice.

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ARSENICAL KERATOSES AND EPITHELIOMAS

BY GORDON MCNEER, M D

OF NEW YORK, N Y

FROM THE SERVICE OF DR FRANK F ADAIR AT THE MEMORIAL HOSPITAL OF NEW YORK

CUTANEOUS changes as a result of arsenical therapy, while infrequent, are occasionally seen in large clinics. This study refers especially to arsenical epitheliomas being based on three such cases, with an additional case of arsenical keratosis.

Hutchinson¹ is usually credited with the first observations of the relationship between arsenical therapy and cancer, although Paris,² in 1825, discussed this condition among tinburrers and smelters. Erasmus Wilson, in 1868, described arsenical keratosis in detail. In 1900, 3,000 people developed arsenical dermatitis in Manchester, England as a result of drinking beer which had been sweetened with glucose containing arsenic. Since 1920, the number of authentic reports of arsenical epitheliomas has doubled. At that time MacLeod³ reported fifteen cases, and Pye Smith has recently collected thirty cases.

Apparently the amount of arsenic taken is not of fundamental significance. Timberlake⁴ discusses acute skin reactions which have followed the ingestion of a single dose of three drops of Fowler's solution. In other cases the lesions have developed after only ten to thirty years' use of this drug. Hamilton's⁵ case had been treated with Fowler's solution for thirty years. Of our patients the one who ingested the smallest total dose (five drops daily for three weeks) suffered the most serious consequences, whereas the patient treated with the greatest amount of arsenic developed merely keratoses. Semon⁶ quotes MacLeod as saying that the average incidence of cutaneous manifestations is two years after ingestion of the drug. Among our four cases the shortest period of elapsed time was one and one-half years, the longest was seventeen years, and the average latent period was seven and one-half years.

According to Osborne,⁷ however, the chemical form of arsenic is of fundamental importance. As a result of microchemical studies he has concluded that the quintavalent group, as found in Fowler's solution, has a predilection for ectodermal structures, such as skin, sweat glands, hairs, *etc*. Epitheliomas therefore occur as a result of arsenic being deposited in the papillary and subpapillary layers of the skin. Osborne has further shown that the amount of arsenic quantitatively determined in the tissues is proportionate to the severity of the dermatitis. Muller⁸ believes that there is an individual susceptibility of the involuntary nervous system to similar concentrations of arsenic in the blood and tissues, a further indication that ectodermal structures other than skin are similarly affected. As a result of their work on arsenical tumors in rats, McJunkin and Calkins⁹ demonstrated the role of arsenic as an aid to the growth of tumors. Ewing¹⁰ has described the close association of arsenic with the formation of acanthomas.

Three types of lesions may occur, dermatitis, keratoses, and epitheliomas. Acute arsenical dermatitis leaves a brownish pigmentation which may last for years, at first accompanied by scales and fissures, numbness and tingling of

the part involved. The keratoses affect mainly the palms and soles, extensor surfaces, elbows and knees, simulating closely the distribution of psoriasis. Many of the lesions are small, flat, erythematous plaques. Others are larger, one to two centimetres in diameter, raised and hard, showing marked thickening and change in the skin surface. Some lesions are manifested by scales, fissures, and crusts, with rolled borders. According to Adair a person afflicted with arsenical keratosis can be recognized by palpation of the palms and soles, which feel as though one were palpating many sharply pointed tacks protruding from beneath the epidermis.

Arsenical epitheliomas are as a rule grade I or grade I plus squamous-cell carcinomas. They are of a low grade of malignancy as evidenced by keratinization and pearl formation. Andrews¹¹ states they may also be of the basal-cell variety, both types of lesions occurring in the same patient. Metastasis to lymph-nodes occurs very late in the disease. In one of our patients the disease has been present for at least fifteen years, but as yet there is no regional lymph-node involvement. Sutton¹² has said that this form of carcinoma does not affect lymph-nodes, but in one of our patients with arsenical epithelioma of the right thumb, the disease metastasized to the right axilla, as proven by axillary dissection and subsequent histological study. Milch¹³ believes that arsenical epithelioma has a low grade of malignancy, stating that the arsenical factor producing the epithelioma may lead to early cornification and hence restraint of growth. The histological picture is one of extensive infiltration of the cutis and subcutaneous tissues by columns of new cells, some of which lie definitely within the lymphatics.

The treatment of these lesions depends on the extent of the disease and the form encountered, and therefore the therapy in each case is an individual problem. When limited to a dermatitis, sodium thiosulfate, injected intravenously in amounts up to one gram daily for six days, has proven successful. Bugg and Folkoff¹⁴ have reported one such case, and Halliday and Sutherland¹⁵ others. Keratoses respond fairly satisfactorily to low-voltage roentgen therapy, and radium applied as a bulb or plaque. Frequently, such methods leave merely a soft pliable scar. Arsenical epitheliomas tax the ingenuity of both the surgeon and roentgenologist, if multiple lesions are encountered. Milch reports a satisfactory two-year cure as a result of surgical excision and subsequent skin grafting of a typical squamous-cell carcinoma of the heel. The case which presents multiple lesions is not so easily solved. One of our patients had a lesion of the right hand so deeply ulcerated that amputation at the mid-forearm was necessary. When dealing with the smaller lesions the electric cautery was found of great value. The low-voltage roentgen rays have proven to be one of our most valuable types of irradiation of the multiple lesions. Adair and Bagg¹⁶ have described the use of mustard gas in the treatment of arsenical keratoses and epitheliomas. One mm of 10 per cent mustard gas in absolute alcohol was placed on each of two lesions on the right arm and chest wall (Fig. 1). In six weeks there were soft pliable scars, and in twelve months there was no evidence of disease. Many lesions so treated

in another patient likewise disappeared. The use of mustard gas solution should therefore be added to the therapeutic armamentarium.

Prognosis as to life is favorable when dealing with arsenical epitheliomas because these lesions are of a low grade of malignancy. In Case I the patient first noticed the lesions on December 3, 1929, and our last examination on September 23, 1931, revealed no evidence of disease, a period of almost two years. In Case II there were definite keratotic lesions in 1916, but the diagnosis of cancer was not established histologically until 1925. This patient is living without disease seven years later. In Case III the patient first noticed



FIG. 1.—(Case I) Showing the distribution of the lesions over trunk, neck, and arms. Arrow points to an ulcerated squamous cell epithelioma. The lesions as a rule are quite superficial and ulceration does not take place early.

the lesions in 1925 and was later found to have an axillary node involvement. The feature of this disease is the great multiplicity of lesions that develop, for as one group is cured, a new crop appears elsewhere. Being aware of their low grade of malignancy the therapist treats each new lesion as it appears, fairly secure in the knowledge that the patient will survive many years.

CASE REPORTS.—CASE I—A R, male, aged thirty-one years, white, single, admitted to Memorial Hospital on December 3, 1929. This man had received thirty drops of Fowler's solution daily for six months in 1912. In May, 1929 a small tumor near the anus was removed at the Walter Reed Hospital in Washington, D. C., where the pathological report was squamous-cell carcinoma. In August, 1929, many small lesions

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appeared on the body. One was excised from the right chest at the Naval Hospital in Washington D C. The pathological report was likewise squamous-cell carcinoma.

Examination showed present (1) Operative scar one inch to the right of the anus (2) On the back, chest, extensor surface of the right ankle were numerous skin lesions, varying from one-half to one and one-half centimetres in diameter. The edges were slightly rolled raised crusted, and pinkish-gray in color. All were freely movable. (3) Over the back were numerous small acneiform red papules. (4) On the dorsal surfaces of both hands most marked on the right, and on the palms, were multiple flat warts. A slide from Walter Reed Hospital showed "squamous-cell carcinoma, grade II, radio-resistant."

With the diagnosis of arsenical keratoses and epitheliomas, there was presented a treatment of one drop of 10 per cent mustard gas in absolute alcohol on the lesions of chest wall and arm. This was done December 5, 1929.

Follow-up—January 20 1930. Lesions healed with soft scars. Last note made on September 23 1931. "No evidence of disease."

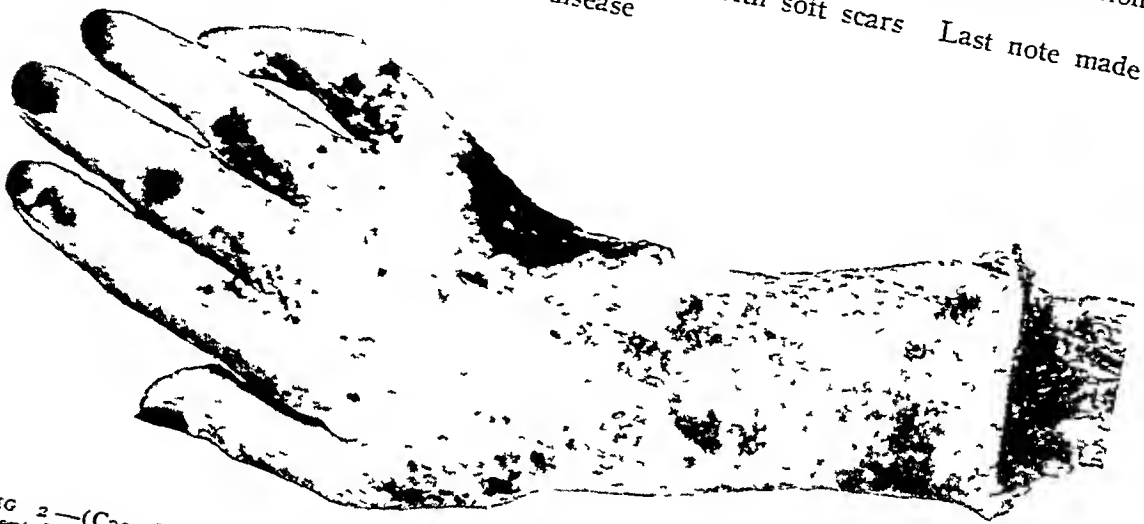


FIG 2—(Case I) Amputated hand and forearm showing the great number of separate and coalescent lesions. On the ulnar side the ulceration is deep. Numerous keratotic areas are noted over dorsum of the hand. The skin is very dry and rough.

CASE II—A F, white single male, aged fifty years admitted to Memorial Hospital November 30 1929. The man had been treated for psoriasis in 1914 by means of five drops of Fowler's solution three times a day for three weeks. He was seen by Darier in France who treated the lesions first seen in 1916 by radiation. This therapy resulted in their disappearance. More lesions appeared in 1925 and the pathological report at that time was carcinoma. Since then numerous other manifestations of arsenical toxicity occurred as described in detail below.

Examination showed present (1) A large ulcerated area on the dorsal surface of the right hand extending to the flexor surface a total of twenty square centimetres (Fig 2) (2) The dorsum of the left hand was likewise ulcerated and bore several small crusted lesions. (3) Over the skin of the trunk and upper extremities there were many reddish-pink, crusted lesions measuring from one-half to two centimetres in diameter. (4) An area of telangiectasis on the back and chest where radium had been applied by Darier.

The pathological report was "squamous-cell carcinoma, grade I radio-resistant." *Treatment*—(a) Surgical. Mid-forearm amputation of the right arm to get rid of a large foul sloughing lesion, and a useless hand. This was performed December 18 1929. (b) Mustard gas was applied to lesions on the left hypogastrium, right anterior chest, left lumbar region, head, right arm, neck, and back. Thirteen lesions in all treated on January 3 1930. By January 30 1930, three lesions had completely regressed. Two months later many of the others were greatly improved.

(c) Radium emanation 16,000 millicurie hours to the dorsum of the left hand, 12,000 millicurie hours in all to lesions of the abdomen, right arm, calf, and shoulder

(d) X-rays Three treatments of 900 r each, at 140 kv to thoracic lesions Five similar treatments to the left neck, shoulder, thigh, and wrist

(e) Electro desiccation of lesions on the left hand

Follow-up—June 28 1932 Many of the lesions so treated were improved, but there was a definite increase in epitheliomas on the back, and a new ulceration near the old one on the left hand November 8, 1932, ulceration on the left hand had definitely increased and some form of surgical intervention must now be definitely considered

CASE III—M D, white, married, male, aged thirty-five years, admitted to Memorial Hospital September 2, 1925 The patient had been taking medicine, chemically proven to contain arsenic, since 1917 About January, 1925, he noticed on the right thumb a wart-like growth, which grew rapidly, becoming scaly and painful

When admitted examination showed multiple areas of keratoses on palms and backs of both hands, right thumb, and soles of feet, an enlarged lymph-node in the right axilla

The pathological report of the axillary node after removal was "squamous-cell carcinoma"

The diagnosis was arsenical keratoses and epitheliomas with metastasis to axillary node

The lesions on palms were treated January 7, 1925, with radium emanation No evidence of disease by February 25, 1927 A surgical dissection of the right axilla removed the affected node which later by histological study was found to be the subject of squamous-cell carcinoma

Radium emanation applied with the bulb was administered in fifteen treatments of 450 millicurie minutes each on the lesions described above

Follow-up—Note on September 23, 1932, "None of the warty lesions on the hand show malignant change The keratotic lesions have not responded satisfactorily to treatment"

CASE IV—A L, white, single, male, aged fifty years, admitted to Memorial Hospital September 4, 1929 This man had received arsenic therapy for anemia in 1904 Several years later he developed the lesions described below

(1) Scattered thickly over the back, palms of the hands, and both surfaces of the feet, were numerous small lesions, the majority being a few millimetres in diameter, reddish and not raised Others were one centimetre in diameter, showing marked thickening and changes in skin surface (2) On the left hand were two small ulcerated lesions, each about four millimetres in diameter

No specimen was removed for histological study as the lesions had not undergone malignant change *Diagnosis*—Arsenical keratosis

Treatment—Radium emanation applied with the bulb, totalling 1,775 millicurie minutes, to the hands and ankles Further radiation therapy by this method was applied to the other lesions described above, using a total dose of about 8,000 millicurie minutes

Follow-up—Last note on July 27, 1931, stated that the right foot and ankle were decidedly improved, but not entirely healed Patient has since been extremely uncooperative and failed all appointments

Summary—(1) Four cases are presented One of arsenical keratosis, and three of arsenical epidermoid carcinoma combined with keratoses

(2) The amount of arsenic ingested, while not fundamentally important, has usually been large, and has been taken over a long period of time The quintavalent form is the type which produces keratoses and epitheliomas because of its predilection for ectodermal structures

(3) Three kinds of lesions are produced dermatitis, keratosis, and epithelioma

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(4) The epitheliomas grow slowly, are of a low grade of malignancy, and but moderately radio-sensitive. Metastasis to the regional lymph-nodes occurs, but late in the disease, as exemplified in Case III. Prognosis as to life is fairly good. Recurrence and progressive crops of lesions appear.

(5) Treatment is a difficult problem. It is frequently necessary to employ several therapeutic agents on the same patient. Surgical excision can be but rarely utilized as there are too many lesions to treat. As the lesions are usually superficial, the low-voltage X-rays or the mustard gas solution have given the best results in our cases. The radium plaques of 1,000 millicurie hours applied to each lesion have also been of benefit.

(6) Frequent observation of the patient is of great importance.

The author is indebted to Dr. Frank E. Adair for helpful suggestions and for permission to report these cases.

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TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD MARCH 8, 1933

The President, DR JOHN DOUGLAS, in the Chair

THYROID NODULES IN THE LATERAL NECK REGION

DR JOHN M HANFORD presented a young woman because her disease was rare, because it exemplified one of the ever-increasing surprises encountered in the neck, because clinically it resembled enlarged lymph-nodes, because the gross appearance at operation suggested a melanoma, because it emphasized the value of a biopsy before undertaking treatment of neck swellings when the diagnosis cannot otherwise be established. This case was the first of a group of three with the same diagnosis in the files of the Presbyterian Hospital. They all came recently within a period of twenty months when none had appeared during the many preceding years. All were females.

October 31, 1930, this young woman, then sixteen years of age, applied at the Vanderbilt Clinic on account of a swelling in the left side of the neck of some four years' duration. She was born and had always lived in New York City. Two sisters had enlarged thyroid glands which subsided under medical care. She herself first noted thyroid enlargement at the age of eleven, which remained constant until it slowly decreased at the age of sixteen. But she noticed that the lateral neck swelling increased as the goitre decreased. Pain in the left ear finally brought her to seek medical aid. She has never had symptoms suggesting hyperthyroidism. Her history and previous state of health were otherwise unimportant. She was a slender, thin, delicate-appearing girl with continued moderate tachycardia, with a simple, smooth, adolescent goitre of small size and with a group of nodules in the left side of the neck, beneath and behind the sternomastoid muscle. These nodules varied in size from one to three centimetres in diameter, were movable, discrete and rounded, not very firm and not very tender. They extended from just below the mastoid process to the middle of the clavicle, corresponding to a chain of deep and posterior cervical lymph-nodes. They were separate from the thyroid gland. They were less firm than most tuberculous nodes, but suggested rather the relatively soft nodes often seen in Hodgkin's disease. Except for the small goitre and the moderate tachycardia, there were no signs of hyperthyroidism. The general physical examination was otherwise essentially normal.

Laboratory studies showed the urine and a complete blood count normal, the Wassermann test negative, the basal metabolism test, minus 10 per cent. X-rays showed no evidence of calcification in the neck or chest, no mediastinal shadows, no evidence of substernal thyroid tissue, and showed the lung fields clear.

November 8, 1930, two of the nodules from the lower part of the neck were removed. They were thought then to have been lymph-nodes. The striking finding was a blackish appearance of the nodules, subsequently found

THYROID NODULES IN THE LATERAL NECK REGION

to have been due to hæmorrhage in the nodules. They were moderately firm but not hard. Each was encapsulated and beneath the capsule were deep purple areas. They averaged 2.5 centimetres in diameter. On cut section they were found composed of moderately firm white tissue with extensive areas of soft purple tissue apparently hæmorrhagic. In one or two places were cystic spaces filled with dark, red fluid. The microscopic picture was essentially that of an adenoma of the thyroid gland with hæmorrhages into some of the acini, large areas of degeneration and areas of hæmorrhage in the stroma. No lymph-node structure was seen. Doctor Stout commented on the slides as follows: The problem is to decide whether this is the primary growth of a remnant of lateral thyroid or whether it is a metastasis from a growth in the thyroid gland itself. Apparently normal thyroid tissue has been known to metastasize. There is nothing in these slides to suggest that these are metastases in lymph-nodes. He concluded, therefore, that these were primary growths from remnants of the lateral thyroid anlage.

A radical excision of all the apparent disease was made November 25, 1930. All of the disease was removed except a possible nodule which lay behind the innominate vein too inaccessible for removal, but this is merely suspicion. The incision extended from the mastoid process downward nearly to the middle of the clavicle and then curved forwards towards the mid-line. The nodules were very numerous and were placed along the internal jugular vein and out in the posterior triangle of the neck. They were removed *en masse* with the vein sheath and with the fatty and the areolar tissue in which they lay. Efforts were made to preserve the accessory nerve and the muscular branches of the cervical plexus.

The post-operative course was satisfactory. During the two years since the operation, she has reported to the Follow-up Clinic at intervals. She has presented a slight diffuse thyroid enlargement with no evidence of hyperthyroidism. A short course of iodine treatment had no effect. She has been well but under-weight and rather pale. When last seen she had slight thyroid enlargement and there was a three-quarters centimetre firm nodule which appeared as if it lay in the left lobe of the gland. The trapezius muscle is not paralyzed nor atrophic. The scar is slightly widened and ridged.

The other two patients mentioned above were fifty-two- and fifty-nine-year-old women. One had had the lump in the neck for sixteen years at least, the other for twenty-five years. The latter presented a large visible mass of very large round nodules in the lower part of the neck. Both were treated by radical excision and have done well since operation. These two patients did not show the extensive hæmorrhages and blackish discoloration of the young woman's nodules. The microscopic pictures were those of thyroid adenomata.

DR WILLIAM BARCLAY PARSONS said that these cases of Doctor Hanford were all cases with lateral aberrant thyroid tissue. Aberrant thyroid tissue may be found in other situations. If one considers the base of the tongue and the thyroglossal tract as abnormal sites for thyroid tissue, in spite of their normal embryological relationship to the thyroid, then thyroid tissue here, as well as the more infrequent separate and distinct intrathoracic masses, must also be kept in mind. The thyroid tissue in these situations is of considerable importance when hyperthyroidism persists following the ordinary partial thyroidectomy. In view of the fact that the histological composition of aberrant thyroid tissue is frequently of the papillary type, and that car-

cinoma is felt to follow adenomata composed of this cellular arrangement, one is forced to consider the relatively great danger of carcinoma in any of the tumors of aberrant thyroid tissue. Cattell, of Boston, reported before the meeting of the American Medical Association in June, 1931, thirteen cases of tumors of the lateral aberrant variety in which there were two adenocarcinomata and five with invasion of the surrounding muscles, indicating the relatively high frequency of carcinoma in these tumors.

TUMOR OF THE CAROTID BODY

DOCTOR HANFORD presented a man of twenty-six years who applied for treatment in December, 1931, with the history of a swelling in the left side of the neck of four years' duration. He thought it followed a sudden wrench of the neck at water polo. At first he had a vague sense of something wrong. A gradually increasing swelling developed with occasional slight variation in size. He described it as a hard lump. He had no pain, tenderness nor soreness at any time and his general health had been very good throughout. There had never been any sensation of throbbing in the swelling. There was nothing to suggest any focus of infection except large, irregular tonsils with very rare sore throat. The family history and past history were not noteworthy.

He was a well-developed healthy young man with no abnormal findings of consequence except the neck swelling. There was a moderately visible prominence in the upper part of the left side of the neck. There was no visible nor palpable pulsation in the swelling. The skin appeared and felt normal and was freely normal over it. On palpation there was a sense of a deep, firm, non-tender mass of ovoid shape, located where one commonly finds enlarged firm upper deep cervical lymph-nodes mostly beneath the sternomastoid muscle. The outline of the mass was rather easily defined in front and behind but not so the upper and lower poles. It was thought to be somewhat nodular. It was slightly movable but the observation was not made as to whether it, like other carotid body tumors reported, was immovable in a vertical direction. As a diagnosis point, this absence of vertical mobility is not of much value because so many of the firm swellings which might be confused with it are likewise immovable in vertical directions because of adhesions to the carotid sheath and to the muscle.

It measured about five by four centimetres in size. There were a few small lymph-nodes in each posterior neck triangle. A complete blood count and urine were normal.

With a diagnosis of tuberculosis of upper deep cervical lymph-nodes, operation was performed in December, 1931, at the Presbyterian Hospital, New York. There was something unusual in the appearance of the tissue at the start. After isolating the internal jugular vein and retracting it backwards it became apparent that there was a mass deep to the common carotid artery at about its bifurcation and above it. The tumor was surrounded by many blood-vessels, mostly large veins, and a good deal of venous oozing followed the blunt dissection which separated it from the surrounding tissue. The lower part of the tumor was covered by the junction of the common facial-ranine trunk with the internal jugular and below this by the bifurcation of the common carotid artery. The tumor was apparently surrounded by a capsule and at no place was there any suggestion of its invasion of surrounding structures outside of the supposed capsule, but at the upper pole it was attached to the superior constrictor of the pharynx or to the fibrous

TUMOR OF THE CAROTID BODY

tissue around it by a dense cord one-half centimetre in diameter and about one centimetre long. This cord was presumably made up of connective tissue, but had sufficient body to it to make one suspicious of its perhaps containing tumor tissue. The accessory nerve was seen and spared. The hypoglossal nerve ran superficially to the upper part of the tumor and was preserved. The vagus nerve was also isolated and spared. The external carotid artery was divided in order to give better opportunity for the removal of the lower pole of the tumor. At the end of the operation there was a most striking pulsation of the bulb of the common carotid where the external had been ligated. The extreme vascularity with dilated veins and profuse number of veins was explained simply by the pressure of the tumor upon the surrounding vessels. After marking the incision-site on the skin with a streak of methylene blue, well below the level of the nerve to the lower lip, an obliquely horizontal incision was made through skin, platysma and deep fascia. An upper and lower flap were reflected. The sternomastoid muscle was retracted backwards. The internal jugular vein was isolated and retracted backwards. The common facial-ranine trunk was divided between ligatures. The external carotid artery was divided between No. 9 silk ligatures and the tumor then carefully dissected out largely from below upward. The internal carotid artery was retracted backwards. This gave excellent exposure so that the final steps of removal proved easy by sharp and blunt dissection. There was considerable oozing so that a Gottie-tube was left in the wound emerging at the anterior angle. Dr. Arthur Purdy Stout, to whom the specimen was submitted for study reported that

The tumor filled all the criteria of a paraganglioma of the carotid body, in spite of the fact that no chromaffin granules could be demonstrated in the tumor-cells. Menetrier reports that it is rare to find them in paragangliomas from the carotid body although they are frequently found in suprarenal tumors. In 1927, Aperlo and Rossi (*Clin. Chir.*, vol. *XXX*, p. 26) collected 114 cases of carotid-body tumors, all of which were probably paragangliomas, although called by many other names. Ninety-six were removed at operation. Of these twenty-three died shortly after operation, eight were known to have had reappearances and fifty-nine showed no evidences of return at varying periods after operation. Only three cases have been known to metastasize, the common site being the regional lymph-nodes.

Diagnosis—Paraganglioma of the carotid body

The patient recovered readily from the operation and has been well up to the present time (March, 1933). He has had no evidence of persistent neoplasm and no paralysis of the hypoglossal nor of the accessory nerve.

The diagnosis before operation in these cases probably will not frequently be made but the early operative findings are often so typical as to lead to immediate diagnosis. The rather high mortality in the past has been due to two main factors, judging from the reports. One is the failure of the operator to define the gross pathology and to extricate the mass in a deliberate anatomical dissection and the other the immediate occlusion of the common or internal carotid artery with its known dangers. If such an occlusion be found necessary, it should be made in two or three stages. Post-operative radiotherapy is not thought necessary where complete removal is thought to have been achieved.

Dr. Charles E. Farr stated that carotid body tumors were extremely rare. According to Rankin and Willbrock (*Annals of Surgery*, vol. *XCIII*, No. 4, p. 801, April, 1931) only twelve cases had been seen in The Mayo Clinic. Bevan, in 1929 (*Surg., Gynec. and Obst.*, vol. *XLIX*, p. 764), reported

one case and tabled 133 cases from the literature, with 35 per cent mortality and practically 9 per cent recurrence. Sullivan, in 1927 (*Surg, Gynec and Obst*, vol xlv, p 209), reported two cases, Winslow (*ANNALS OF SURGERY*, vol lxiv, No 4, p 257, September, 1916) reported two cases, and Mix and D'Aunoy-Rigney reported one case in the *American Journal of Surgery* (vol xiii, No 3, p 529, September, 1931).

Ewing states that the carotid-body tumors usually arise about puberty, increase slowly, growing upon and behind the bifurcation of the carotid. The vessel is often inclosed, compressed or invaded by the tumor.

The diagnostic point, according to Ewing, is that these tumors can be moved laterally but not vertically. They may be present in the pharyngeal wall, they may run up to the skull or downward. Most of them are rounded, lobulated and encapsulated, but rupture of the capsule may occur. They may be firm or soft, may pulsate or give a bruit. They may be vascular or grayish-red or slightly brownish from chromaffin substance in the specific cells. The growth is exceedingly slow, lasting even up to thirty years. Enucleation is usually possible and successful. Local recurrence and local lymph-node involvement are seen occasionally but generalized metastasis is not seen. The microscopic examination is that of alveolar perithelioma.

Doctor Fair described two cases from the surgical service of the New York Hospital, the only ones apparently recognized in the entire history of the hospital. He stated, incidentally, that no case had ever been recognized at St Mary's Hospital for Children. In the records, according to Bevan, one patient of seven and one of nine years of age have been mentioned.

Doctor Fair's first case was a single girl, twenty-seven years of age, who entered the New York Hospital, June 13, 1923, and was discharged June 21, 1923. The growth was in the right side of the neck and had been present three or four years, with some pain and tenderness for a few months. Excision was performed on the basis of a tuberculous node but a carotid body tumor was diagnosed as soon as the field was exposed. The operation was difficult and bloody. The vessels did not have to be ligated. The tumor was three and a half by two by two and a half centimetres. Recovery was uneventful. She received X-ray treatment and remained well for several years, when she disappeared from view. The microscopic examination showed a perithelioma of low-grade malignancy.

The second case from the New York Hospital service occurred in January, 1933, on the service of Dr George Heuer, the operation being performed by Doctor Meagher. This was a married woman, forty-nine years of age, who had had a growth in the left side of the neck for about four years. The diagnosis of tuberculous node was made as there was a distinct family history of tuberculosis and a doubtful past history of tuberculosis of the lungs. The husband suffered from paresis. This patient had a Horner's syndrome and a diplopia. The mass in the left neck was approximately twelve by six centimetres. It was not distinctly in the bifurcation of the carotid but rather behind it. It extended upward behind the styloid process of the temporal bone and was so adherent to the base of the skull that complete removal was impossible.

The microscopical picture was that of a perithelioma of the carotid body.

CALCIFIED CYST OF THE LIVER

It was essentially of a malignant type and prone to recurrence. This diagnosis was confirmed by Dr James Ewing. X-ray treatment has been instituted and will be carried out in the endeavor to destroy the remnants of the growth and to prevent recurrence.

DR EDWARD W PETERSON said that he had operated upon a case of carotid body tumor several years ago. The condition was suspected before operation, as there had been a painless tumor for some years, which had increased in size rather rapidly during the previous year. The growth was about the size of an English walnut, and during the operation uncontrollable hæmorrhage from the substance of the gland made necessary the ligation of the common carotid artery. Six hours later there were no evidences of paralysis but ten hours later there was a complete hemiplegia of the opposite side. Cerebral softening followed and the patient died about four months later. The pathological report in this case showed the growth to be highly malignant and rapidly growing.

Doctor Peterson felt that if the carotid body tumor could not be removed without ligation of the internal carotid or the common carotid arteries, that it was better to follow the suggestion of Bevan and treat the case with radium. The majority of the cases show a low degree of malignancy and respond to radiotherapy.

DR FRANZ TOREK said he had seen only one case of tumor of the carotid body on which he operated over twelve years ago. It was similar to Doctor Hanford's in that he did not make the diagnosis before operation, his diagnosis had been aneurism because strong pulsation was felt on all sides of the tumor. It differed from Doctor Hanford's in that it was soft. Another difference was that the operation was quite difficult, notwithstanding the fact that the tumor was smaller, being only about one inch in diameter. It seemed it would be necessary to tie off the common carotid artery and the internal carotid, but this was avoided by careful dissection requiring removal of portions of the outer coat of the arteries. The internal jugular vein had to be resected with the tumor. After the operation there was a slight adductor paralysis which lasted three months. The patient is now in perfect condition.

Doctor HANFORD, in closing the discussion, said that he was inclined to disagree with Doctor Peterson about leaving in the tumor if the carotid artery had to be ligated for its removal, for he believed that if the tumor could be removed by ligating the carotid artery, it would be better to do this by multiple ligations rather than leave the tumor in. That meant two or three operations but it was perfectly feasible. Most of these tumors are not malignant and one should try to get them out without doing too radical an operation but removing all the tissue that is available.

CALCIFIED CYST OF THE LIVER

DR JOHN M HANFORD presented a man, fifty-two years of age, who first came under observation in August, 1928, at the Presbyterian Hospital. He

was a forty-nine-year-old tailor who was born in Italy. He came to the United States at the age of twenty-two. In the preceding April he had developed weakness, loss of weight, a sense of fullness in the upper abdomen, dyspnoea and swelling of the legs. After extraction of the teeth for neuralgia, he became weaker and finally four months after the onset of these symptoms applied for treatment. At this time the important physical findings were the following: Temperature, pulse and blood-pressure were normal. He looked sallow but not jaundiced. The lungs were clear. There was a definite slight bulging to the right, of the lower chest and upper abdomen. The mid-line of the abdomen was slightly convex towards the right. The liver edge was felt two centimetres below the costal margin and besides there was a stony hard mass, apparently a part of the liver, projecting into the epigastrium. There was pitting on pressure of legs and ankles.

The laboratory findings in general were normal. Gastro-intestinal X-ray study was normal except that a large, rounded shadow with a dense thick margin was seen in what corresponded to the middle half of the liver, below the middle of the diaphragm. The X-ray report stated that it had the appearance of a large cyst of the liver, with calcified walls.

At operation, August 15, 1928, the liver presented a large globular hard mass occupying almost the whole of the left lobe and pushing the right lobe downward and to the right. The wall of the extrahepatic part of the mass was stony hard yet resilient enough to make the mass feel cystic. The gall-bladder and ducts were made out normal. Aspiration of the cyst yielded a minute amount of yellowish amorphous material. A scalpel was passed into the cyst along the needle. The opening was enlarged by breaking off some of the calcified wall. The contents consisted of some 500 cubic centimetres of yellowish, green and brown gelatinous semi-solid, amorphous material without odor. This was scooped out with a tablespoon. The large solitary cavity did not collapse after emptying. The interior looked shaggy and appeared to consist largely of fibrous tissue lining the rigid calcified wall. In the upper posterior part of the cavity there was a recess extending upward in front of the right crus of the diaphragm. After irrigating the cavity it was lightly packed with gauze.

Stained sections of the cyst contents showed many leucocytes, about half of which were polymorphonuclear, many fat droplets and cholesterol crystals. Many large, round cells resembling *Endamoeba coli* were seen. No hooklets nor scolices were seen. The tissue diagnosis was simply necrosis of the liver. Ordinary cultures of the cyst contents were sterile. Examination of the stools revealed no ova nor parasites.

After the operation the discharge from the cavity became very bile-stained, liquid and profuse. On leaving the hospital four weeks after the operation, the cavity measured 350 cubic centimetres. Scrapings from the lining of the cyst were examined, no protozoa and no cause for the cyst were found.

Six months after the operation, in February, 1929, the discharge was less profuse, more yellow and more mucoid. The more he ate and drank the more discharge appeared. X-ray showed the cavity slightly smaller. Much hard calcium was felt within the cavity by means of a probe. A year after the operation he felt generally well but not able to work. He continued to use a tube drain which he changed twice a day. The amount of discharge was about 120 cubic centimetres in twenty-four hours. The cavity measured about thirty cubic centimetres.

In March, 1930, some twenty months after operation, the discharge persisted in small amounts, the cavity measured about twenty-five cubic centimetres, the depth of the calcium-lined track (or liver fistula) measured twelve

CALCIFIED CYST OF THE LIVER

centimetres, and X-rays showed decrease in the size of the calcium shadow. It was thought that spontaneous closure of the track was unlikely because of the dense plaques of calcium lodged in its wall. He was then re-admitted for further study as to treatment. The great need appeared to be removal of calcium so that the track might heal by granulation. His chief complaint then was pain in the right trapezius region. Installations into the cavity of acetic-acid solution, a 7 per cent solution, were instituted. The washings were found to contain calcium, and the calcium in the track felt softer after three weeks of this treatment. The acetic-acid treatment was continued for a time, although it caused great increase of the right suprascapular pain.

Two years after the operation the patient returned for the first time with a smile and saying he was better. The discharge was only about thirty-five cubic centimetres a day, the opening in the abdominal wall was small, admitting a small rubber tube, much calcium was still felt within.

Two and one-half years after the operation, when the biliary mucoid discharge had reached a still smaller amount, he noticed that occasionally, on rising, he spat up a little bitter yellow fluid just like that in the discharge. This condition continued several months until about three years after the operation when, one day, he came to the hospital in great distress due to coughing and raising much yellow, bitter sputum. He was asthenic and had a very low blood-pressure. He was re-admitted for study. Chest X-rays showed evidence of infiltration around the right lower bronchus and its ramifications just above the right half of the diaphragm. Methylene blue injected into the abdominal sinus was coughed up in the sputum on the following day. Bronchoscopy revealed distinct redness of the bronchial mucosa in the right lower lobe. Lipiodol instilled into the right lower lobe was demonstrated in the liver cavity by X-ray, five days later. There appeared to be adequate evidence therefore, to establish the diagnosis of a hepatopulmonary fistula which had formed after the cyst contents found almost complete obstruction at the abdominal outlet.

The therapeutic indications were to reestablish free drainage through the abdomen and to remove calcium with the hope of subsequent granulation and healing of the liver cavity. The fear of hæmorrhage deterred from attempting excision.

October 16, 1931, three and a quarter years after the first operation, the second operation was made. This consisted of excision of the fistula opening, of partial excision of the liver opening, of the removal of all accessible, safely removable calcium plaques, and finally, of the application of the high-frequency coagulating current to all remaining plaques with the purpose of inducing necrosis in their soft-part beds, and their ultimate separation and removal. The hope of healing rested on the presence of granulation tissue seen between the plaques.

The day following operation, subcutaneous emphysema was quite marked in both sides of the lower part of the neck, most marked in the left supraclavicular region. Air is thought to have entered the mediastinum from the abdominal wound, through the diaphragm, and thence up to the neck. By the sixth day after operation, the emphysema and the bile in the sputum had disappeared, the cyst cavity measured twenty-five cubic centimetres, and he felt improved. During succeeding days numerous pieces of calcium were removed from the wound which daily received a pack of 50 per cent silver nitrate solution, designed to cause sloughing away of the plaques. This caused sloughing of soft tissue and of plaques both. Five weeks after operation the track was puddled frequently every day with 2 per cent lactic-acid solution with the idea of removing the calcium or calcium lactate. At this

time the track contained but ten cubic centimetres of fluid and much of the calcium had come away. During the lactic-acid treatment, washings from the track after puddling for twenty minutes revealed about five milligrams of calcium per 100 cubic centimetres of fluid. Doctor Bauman suggested the treatment and made the chemical study.

The patient finally left the hospital in December, 1931, greatly improved, and one month later, three and a half years after the first operation, the abdominal fistula healed to remain healed up to the present time (March, 1933). He steadily improved and has continued to feel well, except for occasional minor symptoms, and he has been working.

It is doubtful if this lesion should be classed as a cyst of the liver. It is evidently neither an amœbic abscess nor an echinococcus cyst. Almost all solitary cysts of the liver (which are rare) are epithelial-lined and are more common in females. It appears to be rather a degenerated, non-malignant neoplasm. The most probable explanation is that this lesion was first an adenoma or cysto-adenoma of the liver, which, because of its fibrous and calcareous boundary, degenerated from loss of blood supply into an amorphous mass. Increase of size causing symptoms may well have resulted from the gradual accumulation of bile seeping into it from uncalcified crevices in its wall.

REPEATED REPAIRS OF LARGE INCISIONAL HERNIA

DR KIRBY DWIGHT presented a man who, at the age of fifty-three years, came to Roosevelt Hospital in May, 1928, with a large incisional hernia. Twenty years before he had been operated upon for a ruptured appendix and the wound had been drained. There had been severe infection of the wound and some slough of fascia.

Ten years before the patient had noticed a swelling in the region of the scar. This gradually increased in size and he began to wear a support. Six months before admission the skin had begun to ulcerate at the point of maximum pressure of the support. This ulcer had remained open and had gradually increased in size. The man was quite obese, but husky and strong, with good abdominal muscles. The hernial sac was very large and contained coils of intestines which could be discerned just under the skin. The defect in the abdominal wall was also large, measuring about twelve centimetres by fifteen centimetres with the long axis extending obliquely from above downward and inward.

This hernia seemed inoperable on account of its size. It didn't seem possible to get that mass of intestines back into the abdominal cavity and then be able to get a decent closure of the defect. And then there was the ulcer. Infection from it would certainly complicate any attempt at repair. But if he kept on wearing a support it was only a matter of time before the ulcer would go through into the coil of small intestine that was adherent just beneath it.

So he was kept in bed for six weeks on a low-calorie diet until the ulcer had healed and he had lost a few pounds in weight, and then he was operated upon.

At operation a wide area of normal skin was excised with the scar of the ulcer in the attempt to avoid contact with the pyogenic organisms that would still be in the scar tissue. It was necessary to dissect very close to the under surface of the scar when separating it from the adherent loop of intestine.

REPEATED REPAIRS OF LARGE INCISIONAL HERNIA

The sac was found to contain the cæcum and omentum as well as a great deal of the ileum, all more or less adherent to the wall of the sac

The omentum was resected and the cæcum and small intestine were reduced, but it was only with the greatest difficulty that the small intestine could be gotten back into the abdominal cavity and kept there while the repair was made. It was subjected to a good deal of pushing and handling. The wall of the sac was so thin and frayed out that it could not be utilized in the repair, and the edges of the defect itself had to be approximated. They could not be overlapped and it was only with great difficulty that they could be brought edge to edge. They were sutured together with strips of fascia lata from the left thigh.

A day or so after the operation the patient began to show symptoms of ileus, vomiting and great distention, medical treatment not proving effective. A medium jejunostomy was done on the sixth day, using the Witzel method. This functioned freely and the vomiting and distention were relieved. Also by this time the hernial wound had become frankly infected and the skin edges had to be separated for drainage. The fascial sutures became necrotic but held sufficiently to prevent a disruption of the wound. In this they were greatly helped by the partial collapse of the intestines following the enterostomy and by a rapid loss of weight due to the same cause.

The jejunostomy stopped draining in about two weeks, the hernial wound healed and the patient was discharged with the repair apparently firm.

A year later, in July, 1929, he returned to the hospital with a recurrence of the hernia. The defect in the abdominal wall was the same as on his previous admission, twelve centimetres by fifteen centimetres, but the sac was shallow, more of a bulge than a real sac, and there was no ulcer. He had dieted and lost weight so that the abdominal wall was quite lax.

At the second attempt at repair the edges of the defect were overlapped for about one and a half centimetres, using heavy chromic gut. Then with strips of fascia lata from the right thigh this seam was overlaid with a lace-work continuous suture.

This repair has remained firm throughout most of its length, but about a year after the second operation two small recurrences appeared or were noticed, one at the lower angle and one at the upper angle.

The third operation was done in June, 1932. The two recurrences, each about three centimetres in diameter, were repaired by overlapping the edges, again using fascia lata from the right thigh. It is only nine months since this last operation and it is too early to promise a cure, but the main part of the defect has been closed.

DR SEWARD ERDMAN said that these large incisional hernias were often very difficult to cure, a recent report from The Mayo Clinic recording 23 per cent recurrences, and other reports running as high as 30 to 40 per cent are encountered in medical literature. He has found that it will sometimes be necessary to resect a large part of the omentum in order to reduce the hernia into the abdominal cavity. The use of an enterostomy in Doctor Dwight's case as a means of combating undue post-operative distention was an excellent measure. Doctor Erdman has recommended the performance of enterostomy in cases where distention increased the hazard of hernia operation, especially in cases of marked strangulation of a hernia, where there is the least doubt of viability of the returned bowel, or where the

returned loop seems liable to remain paralyzed for some time, with resulting dangerous distention

DR CARL G BURDICK said that as regards enterostomy in these large hernæ, if pitressin is used more the indications for enterostomy will be less

An ampule should be given before the abdominal wound is closed and a second ampule before the patient leaves the operating room. An ampule is given every four hours for the first twenty-four and then can be reduced to every six or eight hours for the next day or two depending on conditions

If it is not possible to get an overlapping of the muscle flaps or if they can only be approximated under considerable tension, it is well to reinforce the suture line with a fascial graft. Formerly they were sutured with chromic gut and the union with the muscle was only by connective tissue. Recently the speaker has been using a continuous fascial suture to anchor the graft which overcomes this objection

LUDWIG'S ANGINA

DR HERBERT WILLY MEYER presented a man thirty-five years of age who was admitted to the Surgical Service of Dr. Carl Eggers at the Lenox Hill Hospital suffering from a sore mouth, swelling of the neck on both sides, inability to talk, move the tongue, or swallow and some difficulty in breathing. He had suffered from poor teeth and sore gums which undoubtedly were the primary focus of infection. Five days before admission he had noticed a swelling under the jaw and in his mouth and had pain in the tongue. Fever was slight. The following day he had higher fever and chilly feeling. Intense pain on swallowing developed and two days before admission he was unable to speak or open the mouth. He had high fever for forty-eight hours before admission which at time of operation was 104.6°

Examination showed intense œdema and swelling of the floor of the mouth with a rigid tongue. Both submaxillary regions were swollen but the skin was movable over the swelling. There was diffuse cellulitis of the submaxillary regions and the floor of the mouth. The blood count was 12,500 white blood-cells with 71 per cent polymorphonuclear leucocytes. Smears from the gums showed the presence of Vincent's angina and culture gave a mixed group of organisms.

Immediately upon admission the patient was operated upon under local infiltration anæsthesia. Two incisions were made in either submaxillary region parallel to the lower border of the mandible about two inches in length with an electric-cautery knife. The skin and platysma were incised and the submaxillary space entered. No pus was encountered but marked œdema. The finger was introduced into the submaxillary fossa and passed between the mucous membrane and the mylohyoid muscle from one side to the other. No free pus encountered. The space passing backward towards the neck and the angle of the jaw was also opened with the finger and drainage was instituted by split rubber drains from one submaxillary fossa to the opposite one and tampons placed into the space passing backward and between the floor of the mouth and the mucous membrane. Thus the entire phlegmonous area of the submaxillary region and the sublingual region was widely opened and drained. No pus was encountered but intense œdema.

There was profuse serous discharge from the wound during the first twelve hours. The sepsis was overcome by hypodermoclyses and fluids per

rectum The œdema rapidly subsided in the floor of the mouth The second day the wounds began to discharge foul-smelling pus and to look gangrenous and black Two intravenous injections of neoarsphenamine were given on account of the Vincent's spirillum infection in the mouth On the second day after the operation ten cubic centimetres of streptococcus erysipelatus vaccine were given During the next few days the discharge from the wounds was still profuse and gangrenous fascia was discharged in large amount A spontaneous perforation into the mouth occurred on the second day but it was impossible to locate this on account of the swelling and inability of opening the mouth

Thereafter the patient made an uneventful recovery and was discharged from the hospital on the twelfth day post-operative with clean granulating wounds which took about two more weeks to completely heal

Ludwig's angina must be looked upon as a morbid entity It was described by Ludwig in 1836 for the first time and his description has been confirmed by other writers Delorme considered that it was primarily a phlegmon of the sublingual region but this is undoubtedly incorrect as the disease begins as a submaxillary cellulitis that spreads to the floor of the mouth and to the sublingual regions secondarily

One of the best original articles presented on this subject was published in the forty-seventh volume of the ANNALS OF SURGERY on p 161, written by Dr T Turner Thomas, of Philadelphia This is well worth studying if one is interested in this disease

The frightful rapidity and certainty with which an unchecked case proceeds to a fatal termination should be warning enough for an early recognition of the disease and early radical and extensive incision and drainage even before the development of free pus The dissection of the cellulitis and the inflammatory processes is backward, in fact it is the only direction in which the rapidly accumulating new inflammatory material can force its way and leads to early œdema of the larynx, which is the main reason for the high mortality

The primary focus may be an insignificant one in the mouth as a carious tooth, or it may be tonsillitis or an ulcer in the mouth By lymphatic drainage the infection travels towards the lymph-nodes within the capsule of the submaxillary salivary gland Here it is held for a short time and if the infection spreads by contiguity through the capsule of the gland it develops into a cellulitis of the submaxillary space Any organism may cause the infection It may be the streptococcus alone, or a mixed infection of other organisms as the staphylococcus, pneumococcus or the bacillus of malignant œdema The infection or submaxillary cellulitis spreads along the opening in the muscular buccopharyngeal wall through which the submaxillary salivary gland projects into the floor of the mouth The submaxillary cellulitis thus becomes a sublingual cellulitis This is the sublingual phlegmon of Delorme The mouth and pharynx are thus invaded by the submaxillary infection

The only direction in which the cellulitis of the floor of the mouth can spread is backward. The rigid indurated tongue is pushed upward against the hard palate. The gums and the teeth prevent extension outward and the floor of the infected area is formed by the mylohyoid muscle. Hemmed in on all sides except posteriorly the infection and œdema rapidly spread backward and downward to the larynx which is only two to two and a half inches distant from the main inflammatory focus. Dysphagia and dyspnoea are early symptoms and death results from invasion of the larynx in most cases accompanied by the septic intoxication. It is these alarming symptoms which are characteristic of advancing Ludwig's angina.

The only proper treatment is early recognition and heroic incision into and drainage of the focus from which the œdema is spreading. Local anæsthesia is essential as any general anæsthesia will only increase the difficulty in breathing and swallowing. The median suprahyoid is the safest incision but not the best one in these cases. A wide submaxillary incision on both sides parallel to the lower border of the mandible and wide opening of the submaxillary space and the sublingual space will give best drainage of these areas. If need be the mylohyoid muscle can be incised. It is essential to drain the space between the mucous membrane of the floor of the mouth and the mylohyoid muscle so that drainage can be instituted from side to side through this entire area permitting all of the œdema to drain to the surface. Incision through the mouth is usually not feasible and also not necessary.

DR HENRY W. CAVE considered this a classical case of Ludwig's angina. He commented on the fact that the mortality in these cases is very high and on the fact that in this case particularly immediate incision and drainage decided the outcome. It is of some interest to know that the first case of classical Ludwig's angina, from which Ludwig wrote his vivid description, recovered without the aid of surgery. Six leeches, small poultices and the spirits of Mendeierus effected a cure.

The records of the Roosevelt Hospital show that between the years of 1910-1933 eleven typical cases of Ludwig's angina were treated, eight males and three females, the average age being twenty-eight years. They entered the hospital with a history of symptoms lasting from three to seven days. All complained of swollen necks, difficulty in swallowing and elevation of temperature. Pus was found in six cases. It was necessary to do tracheotomy in two cases and secondary operations were performed in two cases. In these eleven cases there were two deaths, one from an embolus on the fourth day post-operative, the other eight hours after operation, the patient having collapsed on the table and tracheotomy having been resorted to. The course in this condition is described vividly in Ludwig's original article which appeared in the *Medicinishe-Correspondenzblatt* of Wurtemberg Artztlichen Verein, published in Stuttgart in 1836. There is an excellent digest of Ludwig's original article in the *Gazette Medicale* of Paris, 1836.

CARCINOMA OF THE LARYNX

CARCINOMA OF THE LARYNX

DR HERBERT WILLY MEYER remarked that the lymphatic drainage area of the larynx differs from that of the lips and mouth and cheek in that the submental and submaxillary lymph-node groups are not involved. This means that only the anterior chain up to the level of the digastric muscle belongs to the cancer field, but this field does include the posterior deep chain if the anterior chain is involved and in advanced cases the supraclavicular lymph-nodes are also involved. There is one lymph-vessel trunk that passes down and directly enters the supraclavicular region without involving the anterior or posterior deep chain. About one year ago he saw a case who developed a metastasis just above the clavicle following a carcinoma of the larynx, without any involvement in the neck.

The main methods of treatment for larynx carcinoma are radiation and surgery and it seems that the best results can be obtained by surgery. With small intrinsic tumors a laryngo-fissure may be done with the removal of the tumor but in the great majority of cases a laryngectomy is indicated and if there is any extrinsic involvement of the larynx a bilateral lymph-node dissection should be added, removing the larynx together with the lymph-nodes of both sides. On the involved side the lymph-node dissection should include the posterior deep chain, while on the opposite side it is necessary only to remove the anterior chain. He has had two cases in the past years who have remained well for over four years following laryngectomy. In one there was a bilateral lymph-node dissection added while in the other case this was omitted as the patient was almost *in extremis* before the operation. The latter case's condition was so bad that it was decided to perform the operation under spinal anæsthesia. One hundred and fifty milligrams of neocaine were injected into the first lumbar spinal interspace and it was possible to remove the larynx without pain.

He presented a woman, fifty years of age, who was admitted to the New York Skin and Cancer Hospital on the service of Dr Girard F Oberrender of the Nose and Throat Service in June, 1928. The patient stated that she could only speak with a whisper for the past four years following an operation for a rupture. A direct laryngoscopy was performed in June. A benign lesion was diagnosed. September 26, 1928, a biopsy was taken. This time a cauliflower-like growth could be seen below the one vocal cord on the right side and the diagnosis of inflammatory changes was made. Dr George Semken was called in consultation and a radical operation was decided upon. On October 10, 1928, under colonic ether oil anæsthesia a laryngo-fissure was first performed and a cauliflower growth found below the right vocal cord. A frozen section was taken and reported malignant. Hereupon a typical laryngectomy was performed removing the bilateral cervical lymph-nodes together with the larynx from the posterior belly of the digastric down to the omohyoid crossing. The trachea was sutured into a separate suprasternal incision according to the technic of Gluck. The larynx was removed from below upward separating it from the œsophagus and opening into the pharynx at the level of the greater cornu of the hyoid. The pharynx was sutured by two rows of sutures and the skin closed with interrupted silk. At the time of the operation while the pharynx was open an Einhorn duodenal tube was

introduced so that the patient could be fed immediately following the operation. The pathological report was a prickle-cell epithelioma of the larynx, Grade A, with hyperplasia of the lymph-nodes.

The patient made an uneventful recovery and has remained perfectly well up to the present time.

This patient was presented to show that if surgery is contemplated that a laryngectomy with bilateral lymph-node dissection will eliminate the entire cancer field at one time. The stump of the trachea sutured into the separate suprasternal incision makes a nice tracheotomy and the use of the Einhorn duodenal tube introduced at the time of the operation helps greatly in the convalescence of the patient and in wound healing.

DR FRANZ TOREK said that the fact brought out in this presentation that with small intrinsic tumors a laryngo-fissure may be done with the removal of the tumor, but in extrinsic involvement laryngectomy and bilateral lymph-node dissection should be performed, recalled a unique case he had seen last year. In this case, besides involvement of larynx and both sides of the epiglottis, the carcinoma had extended to the back of the tongue. In primary carcinoma of the posterior part of the tongue the indication is to remove the whole tongue, but here the involvement of the tongue was only by superficial extension from the epiglottis, so it was considered justifiable to resect only the affected portion. Excision of the larynx was performed working from below upward. When everything was freed to the hyoid bone the liberated larynx was drawn forward and turned in a direction toward the chin till the posterior portion of the tongue appeared in the wound. It was decided to remove the affected part of the tongue in continuity with the larynx by cautery excision. To accomplish this a suture, directed transversely, was placed in the tongue anterior to the affected area. Traction on this suture brought the tongue into the wound well enough to insert a second suture anterior to the first. The sutures were not tied but simply held so that the cautery knife could be used between the two. Their additional object was to control bleeding, as no preliminary ligation had been done. Fine silver wire was employed to guard against accidental cutting of the sutures by the cautery knife. It was surprising how little hæmorrhage there was in cutting through the tongue. It seems that the part of the tongue immediately in front of the epiglottis is much less vascular than the middle and anterior portions. The physician in charge of the after-treatment used a suction apparatus, the end of which consisted of a spiral wire covered with thin rubber, thus affording a maximum lumen relative to the total diameter of the tube. This was introduced into the trachea off and on to suck out the mucus, and it worked very well. But one day, on removing the suction tube, the wire portion tore off and was found by X-ray to be well down in bronchus. The literature shows that occasionally foreign bodies can remain in the bronchi for a long time without harm so it was decided to leave it there until the wound had completely healed. But over night the patient got up a sudden œdema of the lungs and the next morning was dead, proving that leaving in a foreign body is dangerous practice.

CARCINOMA OF THE PENIS

DOCTOR MEYER presented a man of over fifty who was admitted to the New York Skin and Cancer Hospital in January, 1929, suffering from a large ulcerating epithelioma of the entire glans penis and a portion of the

shaft The tumor was about the size of a lemon and the inguinal lymph-nodes were involved on both sides January 7, 1929, under colonic ether oil anæsthesia, the penis and the skin about its base and the femoral and inguinal lymph-nodes were removed in one mass The pathological report showed a prickly-cell epithelioma Grade B with hyperplasia of the lymph-nodes The urethra was sutured into the base of the scrotum The patient made an uneventful recovery He has been taught to use a urethral sound so as to be sure that no stricture will form at the outer end of the urethra and up to the present time, which is now over four years, he has been entirely well and free from all symptoms

The patient was shown in order to make a plea for an opportunity of performing a series of such cases so that a comparison can be made between such radical surgery, less radical surgery and the end-results obtained by radium and X-ray Also to show the comfort that a patient can live in if the urethra is sutured into the base of the scrotum instead of into the perineum, which necessitates sitting down when voiding instead of standing up as this patient can do The very same principles used in this case in the male can be used when operating upon cancer of the external female genitalia

Doctor Meyer further remarked that there are two schools as to the best treatment of cancer of the penis Perhaps the majority favor X-ray and radium treatment as this method preserves the organ The minority is composed of those surgeons who favor radical surgery At the present time the greater number of cases come into the hands of the radium men while only a few cases come for radical cancer surgery Therefore it is difficult to compare the two methods and determine which is the better of the two It would be fine if in some institution the cases would be divided and half would be treated by radium and the other half by cancer surgery These surgical cases should all be treated and operated upon by a standardized technic so that the results and statistics would be of some value Statistics are of little value from a certain institution if different methods of surgery are employed Cancer surgery eventually will be standardized and this will depend upon a careful study of the primary lesion and the lymphatic drainage area This shows that the lymphatics pass along the dorsal portion of the penis and then pass along the skin to the femoral and inguinal lymph-nodes One lymph vessel passes into the inguinal canal and enters the lymph-node that lies just within the external ring From here the drainage enters the lymph-nodes along the external and later common iliac veins Technically, it is possible to remove the penis and the skin about its base and the inguinal and femoral lymph-nodes all in one piece crossing the cancer field only at that point where the lymph vessels pass into the abdomen Closure is good and if a stump of the urethra is left this can be sutured into the base of the scrotum so that the patient can urinate standing up, which is a great advantage over the perineal urethra It is not necessary or indicated to remove the testes or the scrotum in any case unless the scrotum is involved in the primary malignant lesion

DR FRANK E ADAIR said that carcinoma of the penis is a disease possessing a high mortality. At the Memorial Hospital the cases are handled along a little different line than in most institutions. In other clinics the usual practice is that of a radical amputation of the penis which operation also includes both groin node basins all in one big block dissection. This operation has a considerable mortality. At the Memorial Hospital the primary lesion is treated either by amputation or irradiation, depending on the exact extent and the amount of infiltration of the tumor, and a waiting attitude is assumed as to the treatment of the groin nodes. On account of the fact that an epithelioma of the penis is nearly always ulcerated, the clinician is uncertain (unless it happens to be an advanced case) as to whether he is dealing with inguinal nodes that are infected or cancerous. This point is determined by an amputation of the penis two centimetres proximal to the lesion. We then wait to watch the change that will occur in the nodes. If the groin nodes are those of infection they will resolve and disappear, if cancerous, the hard nodes remain. If the primary lesion is small (under two centimetres in diameter) and superficial, the most ideal form of treatment is that of the application of a radium plaque for 1,200 millicurie hours at a distance of one centimetre. This method of treatment is most satisfactory and gives a very high percentage of cures. Dean (*Ann Jour of Surg*, vol v, No 1, p 32, July 1928) reported thirteen such cases from the Memorial Hospital. By this method of treatment twelve of the thirteen cases (92 per cent) were alive, well and free of disease. On the other hand, if the tumor is large and has penetrated Buck's fascia involving the cavernous tissue, the groin nodes are usually involved. The problem is then chiefly surgical. In this latter group the penis is amputated two centimetres proximal to the epithelioma. Incidentally, one does not get local recurrence following such an amputation. Later the groin nodes are then attacked by one of two methods: (1) A careful groin dissection on both sides. (2) By the introduction of gold seeds containing radon of 15 millicuries each, into this node-bearing area. This area is then subsequently treated by radium packs or high-voltage X-ray.

Squamous-cell epithelioma, unlike basal-cell, is usually resistant to irradiation. There are, however, those Grade III and Grade IV types which are very radiosensitive, but they are rare. Too frequently, these cases go for a considerable period without a biopsy, being treated for chancie. Much valuable time is thereby lost, while the therapy becomes more difficult and the end-results poorer. The tight prepuce with its underlying irritating desiccated smegma is believed to be the basis of this disease. We have never seen an instance where epithelioma of the penis developed in a case circumcised during infancy. This fact accounts for the complete lack of this disease in the Jews and Mohammedans.

PERFORATION OF THE JEJUNUM

DR JOHN C A GERSTER presented a man, forty-four years of age, who was admitted to Doctor Stetten's service, Lenox Hill Hospital, February 16,

PERFORATION OF THE JEJUNUM

1933 Six hours previous to his admission, he experienced severe epigastric pain, while lifting a heavy object. A hypodermic of morphine did not afford relief. He came to the hospital, making his own diagnosis of perforated gastric ulcer, because the present symptoms were identical with those he had experienced two and a half years previously, when he was operated on at St John's Hospital, Long Island City, for perforation of a duodenal ulcer.

He was in good general condition. Locally, there was a firmly healed right epigastric scar on the abdomen, about four inches long. There was board-like rigidity of the abdomen.

He was operated on within an hour of admission. Upon opening the peritoneum, gas and considerable bile-stained, turbid, free fluid escaped. Many post-operative adhesions of omentum, stomach, gall-bladder, duodenum and liver were freed. The first and second portions of the stomach were found moderately filled with gas. Entire anterior aspect of stomach from cardia to pylorus minutely inspected, duodenum likewise, no perforation to be seen. Omentum and transverse colon then freed from their adhesion to anterior abdominal wall, over to right lumbar gutter. Upon turning up omentum and transverse colon, much more bile-stained, turbid, free fluid was aspirated from both lumbar gutters as well as pelvis. Moderate amount of fibrin found in all four quadrants of the abdomen, causing many adhesions. The appendix appeared normal.

Inspection of the jejunum, beginning at the duodenojejunal flexure, revealed a small perforation on the anterior wall of the jejunum, about one-half centimetre in diameter from which bubbles were escaping. This perforation was directly opposite the more distal end of a posterior suture gastroenterostomy, and midway between upper and lower borders of the jejunum. Perforation closed with one fine silk mattress suture reinforced by a second inverting suture. Transverse colon and omentum replaced in normal position, wound closed in layers.

The patient has made an uneventful convalescence. Subsequent correspondence with St John's Hospital revealed that his previous perforation was in the first portion of duodenum and that prior to perforation there was a long ulcer history.

The case is presented because of the comparative rarity of acute perforation of the jejunum.

DR DEWITT STETTEN felt that this case was of great interest from two standpoints. The first was the extreme rarity of perforated jejunal ulcer. Doctor Stetten has seen a considerable number of jejunal and marginal ulcers after gastroenterostomy, but never before has he encountered a free perforation of this variety of ulcer. In fact, he has never heard of a case that has been published in the literature. These ulcers may become penetrating, but, owing to the peritoneal adhesions at the site of the gastroenterostomy, perforation is highly improbable. The second point of interest is the etiological factor of the perforation particularly important to the patient from the standpoint of compensation insurance. In this case there seems to be no doubt that the perforation was the direct result of strain, as it occurred immediately after the patient lifted a heavy radiator and it should be regarded as a compensable accident. It can be readily understood that a sudden violent contraction of the abdominal muscles can increase the intra-abdominal pressure and can squeeze the jejunum against the spine and thus rupture a weakened ulcerated area. Had it not been for this unusual strain the ulcer

may have become covered with fibrin and adhesions and a free perforation may never have occurred. Last year Doctor Stetten was consulted in a case of rupture of the ileum from indirect violence. A man had fallen rather heavily on his ischium and shortly after the fall developed acute abdominal symptoms. He was taken to a hospital where, after a short period of observation, an abdominal operation was performed. A ruptured ileum was found and repaired, but the patient succumbed. Doctor Stetten was asked whether this type of indirect violence was a competent cause for the rupture of the intestine and he gave his opinion in the affirmative. He felt that the intense contraction of the abdominal muscles could cause the rupture almost as readily as the better recognized and commoner cause—namely, severe blunt force to the abdomen, such as a horse's kick or a crush from an automobile accident. Other observers have substantiated this view, and, if a normal ileum can be ruptured by the contraction of the abdominal muscles, certainly an ulcerated intestine can also be caused to perforate.

EPITHELIOMA OF THE LIP WITH PARTICULAR REFERENCE TO LYMPH-NODE METASTASES

DR ROBERT H. KENNELDY read a paper with the above title for which see page 81, and presented five patients to show cosmetic and functional results after block dissection of the cervical lymph-nodes. All were operated on at the Stuyvesant Square Hospital.

DR CARL EGGERS called attention to two important points:

(1) The seriousness of epithelioma of the lip which is so often considered a rather harmless lesion, and

(2) The importance of treating this particular growth the way other cancerous lesions are treated, namely, by the excision or destruction of the local growth, and the removal of the lymphatic drainage area of that region.

With the advent of the Röntgen-ray and radium in the treatment of malignant tumors, a certain amount of confusion has resulted. It is known that radium is most effective in lesions of the mouth, skin, and uterus. It is on the primary lesion in all these localities that the good results are noted, not on the metastatic lymph-nodes, for it is generally admitted that adult type epidermoid carcinoma is very radioresistant.

In considering the treatment of malignant mouth lesions, of which epithelioma of the lip is one, two schools of thought have developed. One, in a general way, is represented by the radiologists, the other by the surgeons. It is not so much on the treatment of the primary lesion that they differ, for the views of the surgeons on the treatment of the primary lesion have always been liberal, they have admitted, and do admit today, that not only excision of the lip lesion with the knife will cure it, but that it may be cured by excision with the electrocautery knife, or that it may be cured by destruction with the cautery, electrocoagulation, radium, Röntgen-ray, or other methods. It is on the treatment of the lymphatic drainage area that there is considerable difference of opinion. The surgeons feel that no consideration of the treat-

ment of an epithelioma of the lip is complete which does not include the lymphatic drainage area, for it is known that the primary tumor frequently remains localized for only a short time, and that there is great tendency for cancer-cells to spread into the lymph-nodes draining that area. This tendency, as a rule, is greater in the small infiltrating ulcerating growth than in the papillary variety. How should this invasion be met?

In a general way it may be said that radiologists are guided by the thought that prophylactic external radiation over the neck by means of the Röntgen-ray or the radium pack in the grossly uninvolved cases is sufficient. It is their view that in the great majority of cases no neck metastases will develop if the primary tumor has been cured by radium. They do not expect a cure of lymph-nodes already involved, but believe that irradiation stimulates the normal resisting power of lymph-nodes to carcinomatous invasion. In case the lymph-nodes are grossly involved, or subsequently become involved, they are either excised in a surgical manner by block dissection, or they are treated with interstitial irradiation by the implantation of radium into the wound.

Surgeons, on the other hand, follow the reasoning that it is not possible to tell by external palpation whether invasion of lymph-nodes has taken place, and that small cell nests may be present very early. They are guided by the experience of years, which has shown that if a cancer has invaded the neck, the outlook for permanent cure is bad. They therefore practice routine block dissection of the neck in the majority of cases, before there is any clinical evidence that the lymph-nodes have become involved.

Our knowledge concerning the nature of malignant growths, their spread and their successful treatment, has been gradually acquired. There was a time when only the local lesion was excised, and it was because of the many poor results that surgeons began to remove involved lymph-nodes. Later on, stimulated largely by the studies of the lymphatic system by Kuettner and others, surgeons went a step farther and removed the nodes before there was any clinical evidence that they had become invaded. This practice is still being followed by the majority of surgeons, and on the basis of Doctor Kennedy's report it appears that it will be wise to continue it. He reports that among ninety-eight patients operated on in whom cervical lymph-nodes were palpable before operation, malignant involvement was found in thirty-two, or 33 per cent. This illustrates that the mere presence of enlarged nodes gives no definite evidence whether they are involved. Still more interesting is the finding of involved lymph-nodes in nine patients, or 14 per cent of a group of sixty-four patients in whom no lymph-nodes were palpable before operation.

As in all other surgical conditions, we must use judgment regarding the indication for, and the extent of, an operation. We know that lip lesions vary a great deal in malignancy, and that the papillary variety is less apt to metastasize than the infiltrating ulcerating variety. It may, therefore, be perfectly safe to be satisfied with a simple excision or destruction of the lesion in the former group, especially if it is possible to have a careful follow-up. In Doctor Kennedy's series of 246 cases fifty did not have a neck

dissection done. In the majority of patients, however, one offers them a better chance of life if the regional lymph-nodes are removed together with the primary lesion.

DR JOHN M. HANFORD said that there was accumulating evidence that some of these lip epitheliomas were in a class by themselves. Some are small and do not invade the muscle and microscopically indicate low grade of malignancy and have no palpable lymph-nodes. It is rare to see extensive surgery for basal-cell epitheliomas because these so rarely metastasize to lymph-nodes. Likewise there is a certain type of lip epithelioma that so rarely metastasizes to the lymph-nodes as to make radical surgery equally contra-indicated. The work of Ragaud at the Radium Institute of Paris and the experience at the Huntington Memorial Hospital in Boston have established a certain group of lip cancers which appear to be best treated by radium for the lip and by no treatment of any kind for the neck. A critical analysis of these cases is very important.

STATED MEETING HELD AT THE NEW YORK HOSPITAL MARCH 22, 1933

THE formal session was preceded by a series of operations in the amphitheatre of the New York Hospital by the following members of the surgical staff of that hospital: HEUER, *Thoracotomy for Intrathoracic Tumor*, POOL, *Laparotomy for Diverticulum of the Jejunum*, ANDRUS, *Gastroenterostomy for Duodenal Ulcer*, FARR, *Subtotal Thyroidectomy for Goitre*, DINEEN, *Laparotomy for Gastric Ulcer*, ERDMAN, *Hemiplasty for Ventral Hernia*, BOWERS, *Cholecystectomy for Cholelithiasis*, MEAGHER, *Subtotal Thyroidectomy for Goitre*.

The following short papers from the SURGICAL RESEARCH LABORATORY of the Hospital were read:

A POSSIBLE RÔLE OF THE TOXIC FACTOR IN INTESTINAL OBSTRUCTION

BY WM. DEW. ANDRUS, M.D., AND GEORGE M. GUEST, M.D.
OF NEW YORK, N. Y.

FROM the enormous mass of work which has been done on intestinal obstruction the fact that death in high obstruction may be due to the action of one or both of two lethal factors may be considered as fairly well established. The first of these is a severe derangement of the normal acid-base equilibrium of the body, brought about by the fact that fluid containing chloride—and to a lesser extent base secreted in the stomach and duodenum—is lost to the bodily economy through being vomited, or through being prevented, because of the obstruction, from reaching that part of the intestine where it would normally be reabsorbed. The second factor is a toxæmia, and while the source, mode of absorption and exact nature of this toxic factor are still the subject of some difference of opinion, its existence in most cases is generally recognized.

In simple midduodenal obstruction in dogs it seems that it is possible

to produce a condition in which the acid-base derangement plays the chief and indeed perhaps the only rôle. Either that is the case or the administration of NaCl neutralizes the toxic factor in this instance. Despite the prominence assigned to this last idea, *i.e.*, the neutralization of the toxin by NaCl—by Haden and Orr, the evidence for it is meagre at best, since NaCl will not neutralize the toxin *in vitro*, nor will the administration of NaCl prevent death when the toxin is injected intravenously.

In patients, however, the additional factor of strangulation, adhesions, *etc.*, with toxæmia is apparently added in most of the cases, and the administration of NaCl alone, while beneficial, does not produce the striking results seen following its use in simple midduodenal obstruction in dogs, where life may be prolonged for as long as thirty days if forty to fifty cubic centimetres normal saline per Kg. be given for the first five days to a week after obstruction.

In attempting to study further the mode of action of the toxic factor we were struck by the fact that almost all of the work on the effect of injection of the toxins has been done on animals whose gastro-intestinal tracts were intact, and this applies in a measure at least to the work with closed loops, where for the most part the continuity of the tract was established after the isolation of the loop. The present work consists of a study of the effects on the blood chemistry and duration of life of histamine, in animals with intact gastro-intestinal tract and in those with high intestinal obstruction. Histamine was selected because of the similarity of its action to that of the toxic substance or substances which can be isolated from the bowel content of animals dead from intestinal obstruction, because of the fact that its pharmacological action is fairly well known and because, being available in the form of a pure salt, its dosage can be accurately controlled. Further, most of the evidence accumulated from many different studies indicates that the toxic agent in intestinal obstruction is some product of protein degradation—probably several related substances—and that many of the properties and effects of these substances are like those of histamine.

An attempt was made in this work to avoid overwhelming single injections of histamine and also to avoid intravenous injection, as it was felt that massive doses injected intravenously may provoke symptoms of shock, whereas the injection of small amounts (1 milligram) subcutaneously at hourly intervals, it was thought, should more nearly simulate the conditions imposed by the gradual absorption of toxic products from the obstructed bowel.

Pyloric Obstruction (No. 266).—In a dog are illustrated the typical changes observed in the blood of a dog with simple pyloric obstruction. The principal changes demonstrated in this experiment are: (1) The relative cell volume increased in the second blood sample but decreased again in the third sample. The erythrocyte size was unchanged in the last sample, but ordinarily there is observed a slight diminution in this value. (2) The hæmoglobin content of the cells remained practically unchanged, demonstrating that in this important constituent the red cells remained normal. (3) The serum protein and the nonprotein nitrogen increased. (4) The chloride fell markedly in both plasma and cells. (5) The CO₂ content of both plasma and cells increased in the second sample, but fell termi-

nally, presumably because of the increase of organic acids which is to be expected at this time (6) There was a marked increase of the organic acid-soluble ester-P of the cells, evident in the figure for this fraction in the packed cells (84.5 milligrams per 100 cubic centimetres) and in the ratio of ester-P RBC count The next greatest change of the blood phosphorus was in the inorganic fraction in the plasma

Normal Dog Injected with Histamine Followed by Pyloric Obstruction and Repeated Histamine Injections (No 272)—A normal dog was subjected to hourly subcutaneous injections of one milligram of histamine, in 10 cubic centimetres of 0.9 per cent NaCl solution, for forty-eight hours Food was withheld Throughout this period the animal manifested no outward signs of ill effects of the injections at any time Blood samples were taken for analysis before the injections were started and again at twenty-four and forty-eight hours After sixteen days of rest a pyloric obstruction was created and immediately after six hours had been allowed to elapse for recovery from the ether anaesthesia the dog was subjected to the same hourly subcutaneous injections of histamine as before Blood samples were again taken at the intervals indicated in the table The injections of histamine in the unoperated animal were almost without significant effect on the blood There was a slight but measurable diminution in size of the erythrocytes, 65.5 to 62.4 cubic microns, and a slight diminution of the chloride, more noticeable in the cells The ester-P of the cells increased slightly After pyloric obstruction, sixteen days later, the same injections of histamine were attended by rapid changes in the blood, as follows (1) concentration of the blood, indicated by the increasing red blood-cell count and increased serum protein (2) Loss of chloride and increase of CO_2 in both plasma and cells (3) Increases of the total phosphorus, practically all in the ester-P fractions in the cells These changes were in no wise different from those observed in other dogs with simple pyloric obstruction, but developed more rapidly In the last blood sample, taken one hour before death (twenty-two hours after operation) after sixteen injections of 1 milligram doses of histamine, the magnitude of changes in the blood is, as in the previous experiment, approximately that seen in dogs with simple pyloric obstruction at seventy-two hours, or longer, after operation

Pyloric Obstruction + Salt Solution + Histamine (No 297)—In dogs with simple pyloric obstruction the parenteral administration of NaCl solution in appropriate amounts (around fifty cubic centimetres or more per kilo) prolongs life in the animals and diminishes the alterations of the blood If the effect of histamine in hastening death in obstructed dogs is mainly one of stimulating gastric secretion and thus accelerating the losses of chloride from the body, then the administration of salt solution in sufficient amounts theoretically should protect these dogs as well as those with simple obstruction The following experiment was performed to determine whether such protection could be obtained

In a dog weighing twenty-one kilograms the pylorus was obstructed under ether anaesthesia, with the usual technic Immediately after operation 1,500 cubic centimetres of salt solution were given subcutaneously Again, at twenty-two hours after operation 1,000 cubic centimetres of salt solution were given At thirty hours after operation a blood sample was taken and immediately afterwards hourly subcutaneous injections of one milligram histamine in 10 cubic centimetres 0.9 per cent NaCl solution were started (This interval of thirty hours before starting the histamine injections was allowed so that the dog might recover from the immediate effects of the anaesthesia and operation A repetition of this experiment, in which both the histamine injections and the parenteral administration of salt solution were started immediately after operation, gave almost exactly the same results as shown here, so this time interval appeared to be unimportant) Salt solution was again given at thirty-six hours and forty-eight hours, and another blood sample was taken at fifty-two hours after operation In this blood sample No 3 the cell chlorides were found to be low and in the next twenty-four hours the administration of salt solution was increased In the last blood sample, at seventy-eight hours, the chlorides of both plasma and cells were again at practically the initial level The nonprotein nitrogen had remained normal

TOXIC FACTOR IN INTESTINAL OBSTRUCTION

The dog was sacrificed after the blood sample taken seventy-eight hours after operation (forty-eight hours of histamine injections). The experiment had been continued long enough to demonstrate that the dog could be kept alive by the parenteral administration of salt solution well beyond the time at which death occurred in dogs with obstruction, similarly injected with histamine but not receiving salt solution. Were it not for the exigencies of the experiment—the large blood samples that had been taken, *etc*—it seems likely that this dog could have been kept alive for even a longer time by this treatment.

Discussion—In these experiments it is demonstrated that when dogs with pyloric obstruction are injected with small repeated doses of histamine, they develop more rapidly all the chemical changes of the blood which are ordinarily associated with intestinal obstruction, and die much more quickly than do the untreated dogs with simple obstruction. In normal unoperated dogs similar injections of histamine continued for even longer periods were without visible deleterious effects and caused only slight changes in the blood. Histamine thus injected is known to have a powerful effect in stimulating the secretion of gastric juice. In normal animals these secretions presumably pass through the pylorus into the intestine to be re-absorbed and again form part of the body fluids. However, in animals with obstruction and vomiting, such stimulation of the gastric secretion must accelerate the losses of these secretions from the stomach and therefore hasten the development of all the chemical changes which occur in the body in consequence of these losses. If one accepts the existing evidence that the alterations of the blood and body fluids ordinarily observed in simple high obstruction are due mainly to the losses of water and electrolytes by vomiting, it seems reasonable to believe that the same mechanism is operative in producing the altogether similar changes that are observed when dogs with obstruction are injected with histamine. It seems unnecessary to postulate a general toxic action of the histamine on the body tissues to explain the effects of histamine, in such doses as used here, in hastening death in the unobstructed animals. The immediate death with the symptoms of “shock” that follows the intravenous injections of larger doses of histamine may be due to a different mechanism.

Work is in progress to determine whether or not the effects of subcutaneous injections of the toxic substances (proteoses or amines?) from the contents of the obstructed or strangulated intestine, or from closed loops in dogs, are closely analogous to this effect of histamine. The absorption of such substances conceivably might be sufficiently rapid to cause immediate death with manifestations like those observed after the intravenous injection of these toxic substances, but in clinical experience such a circumstance is certainly exceptional. It is likely that the slow absorption of these substances will be found to have an effect similar to that of histamine in stimulating the flow of gastric juice (Dragstedt and Dragstedt (1922)), if this be true, then it is possible that a most important effect of the slow absorption of toxic substances from a strangulated portion of bowel consists of an acceleration of all those chemical or metabolic effects which ultimately cause death.

NEW YORK SURGICAL SOCIETY

STUDIES IN TUBERCULOSIS

By POL N CORYLLOS, M D

OF NEW YORK, N Y

THE frequency of atelectasis of the diseased portion of the tubercular lung, and its importance in the evolution of the disease, have been already studied (Rev of Tuber, June, 1933)

The strict aerobic character of the tubercle bacillus, especially of the human species, shown by Novy and recently by Loebel, Richardson and Shorr, the exclusion of oxygen in the affected portions of the lung following the production of atelectasis, the clinical improvement noticed in cases in which atelectasis or fibrosis is present, and more especially the results obtained by surgical collapse of the lung, gave me the idea of a possible relation between these phenomena

Experimental investigation on this subject is being carried on this year. There are not, as yet, any definite results to be reported. I was asked to present in a few words the technique which has been followed so far.

As the experimental animal I chose the dog. This animal, however unsuitable for thoracic investigation because of the complete permeability of its mediastinum to air and even to fluids, presents a number of special features favorable to this kind of experimentation, first, the trachea and bronchi of a dog of ten kilograms are almost as large as in the human, which makes intratracheal work and exploration by means of the ordinary bronchoscopic set easy and effective, second, previous extensive work in experimental atelectasis, pneumonia and suppuration of the lung have familiarized me with the interpretation of radiographical changes in their lungs, third, the intraperitoneal method of anaesthesia by means of sodium amytal, which has been used for several years, permits the avoidance of any disturbing irritation of the lungs.

Tuberculosis was given to these animals by intratracheal injection of tubercle bacilli emulsion, using for the purpose cultures of previously well-established virulence. Two varieties have been used so far, both human, R 1 and H 37, both given to me by Doctor Petroff, of the Trudeau Laboratory in Saranac Lake.

New animals or animals previously sensitized have been used. In new animals 0.5 to 1 cubic centimetre of R 1, or H 37 emulsions (0.0001 of culture in 1 cubic centimetre) was injected into the bronchi of the lower or the upper lobe. Tuberculosis has been produced as a rule with H 37.

Other animals were inoculated subcutaneously with R 1, still others with H 37. After five to seven weeks intrapulmonary injections were given. The results so far obtained are most interesting. They are still too recent to be reported.

In other animals small amounts (0.1 cubic centimetre) were injected into the bronchus, followed by 0.5 cubic centimetre injection of the same

culture into the same bronchus three, four and five weeks later, with the idea of obtaining a local sensitization of the organ

Interesting results thus far seen include massive involvement with clean-cut atelectasis in the affected lobe, a gelatinous pneumonic lesion, caseation and even spontaneous pneumothorax. Thus, a difficult part of the problem, which is the experimental production, at will, of a given form of tuberculosis in the lung of the dog, seems to be almost solved. The second part of the problem, namely, the influence of experimental obstruction of the bronchus leading to the diseased lung, will begin shortly

FURTHER STUDIES IN PNEUMOCOCCIC BRONCHIAL OBSTRUCTION

POST-OPERATIVE ATELECTASIS, POST-OPERATIVE PNEUMONIA AND
LOBAR PNEUMONIA

BY GEORGE L. BIRNBAUM, M.D.

OF NEW YORK, N. Y.

THE question of the pathogenesis, prevention, and treatment of post-operative atelectasis and post-operative pneumonia are of considerable practical importance in surgery. In previous publications Doctor Coryllos and I have pointed out the importance of complete bronchial obstruction with viscid pneumococcic exudate in the pathogenesis of these post-operative complications as well as in lobar pneumonia.

In lobal or massive post-operative atelectasis, pneumococci, especially group 4, are always present in the sputum. Similarly, lobar pneumonia is almost always associated with pneumococci. This incidence is explicable on the basis of the type of exudate which pneumococci produce in both instances—an exudate viscid enough to occlude a lobar bronchus and cause air absorption and atelectasis. This bronchial occlusion is facilitated or aided in post-operative cases by such contributory factors as the abolition or reduction of cough reflex by the anæsthetic or narcotics, by voluntary inhibition of painful cough or breathing, and by constrained posture and thoracic or abdominal dressings which may hamper respiration. In contrast to lobar atelectasis and lobal pneumonia, lobular atelectasis and lobular pneumonia are usually associated with other organisms than the pneumococcus, such as staphylococci, streptococci, etc.

By physical and roentgen signs or even by the gross pathological appearances, it may be impossible to distinguish post-operative atelectasis, post-operative pneumonia and lobar pneumonia. In a general way, the clinical toxicity is proportionate to the virulence of the pneumococcus concerned. In lobal pneumonia there is a more marked degree of pneumococcic cellulitis and alveolar exudation, factors which may make the underlying or basic atelectasis less evident in the gross pathological and roentgen pictures.

Experimentally, various phases of the question were studied in animals

by means of bronchial obstruction with a special balloon, and by the intra-bronchial instillation of pneumococcus cultures and human pneumonic sputum. Instillation of pneumococcus cultures or of human pneumonic sputum into the bronchi of dogs produced either evanescent symptoms or the clinical and roentgen pictures of lobar or massive atelectasis. Some of the latter cases went on to spontaneous recovery, others terminated fatally. Presumably, the virulence of the pneumococcus concerned was the factor determining the outcome. The toxic or fatal conditions in this group were clinically comparable to lobar pneumonia, whereas the less toxic ones in which recovery occurred were clinically comparable to lobar or massive atelectasis. In man, the same difficulties of diagnosis are encountered, and the differential diagnosis between post-operative atelectasis, post-operative pneumonia and lobar pneumonia may rest largely on the factor of toxicity, when the other symptoms and signs run closely parallel. The symptom complex in pneumococcal bronchial obstruction is variable. The immediate cause is bronchial obstruction and the underlying or basic pathological condition produced is alveolar air absorption and atelectasis. The clinical aspect, however, depends on the size of the occluded part of the lung, the duration of the bronchial occlusion, the type and virulence of the pneumococcus concerned, the character and the amount of alveolar exudate and the complications which may arise.

The fundamental soundness of our concept has recently been challenged by the contention that early in clinical and experimental lobar pneumonia little or no signs of atelectasis are found clinically or roentgenographically, further, that when roentgen signs of atelectasis are found they are slight and the shift of heart and mediastinum to the affected side may then be explained by an "increased elastic tension" of the involved lobe which hinders inspiratory inflation of the pneumonic lobe. The present studies which are shortly to be published were undertaken with the view of testing the validity of these contentions which we have found to be entirely erroneous.

BACTERIOLOGICAL STUDIES

BY EDWARD W. SAUNDERS, M.D.

OF NEW YORK CITY, N. Y.

SINCE the early days of bacteriology, microorganisms have been found in cultures made from malignant growths. The chief criticism of the results has always been the lack of constancy in the findings—bacilli, diphtheroids, cocci, streptococci having all been isolated from the same types of tumor.

The recent development of bacteriology, particularly the increasing evidence that the external form of a microorganism means nothing as regards its classification and that many, if not all, microorganisms seem to pass through a developmental cycle in which all of the forms—rods, diphtheroids, cocci and granules—may appear at some stage or other, made it seem worth

BACTERIOLOGICAL STUDIES

while to reconsider the problem of the bacteriology of malignancy from these newer points of view

Our work thus far leads us to the belief that we are dealing with an identical streptococcus, proved so bacteriologically by agglutination, cross-agglutination, and agglutinin absorption, which has been isolated by tissue culture seventy-four times as shown in the table following

Gastric ulcer and Ca	35
Breast Cancer	11
Breast Cancer blood serum	2
Cervix	8
Rectal cancer	2
Ulcerative colitis	2
Hodgkins gland	2
Thyroid	1
Mouse Cancer	6
Milk	3
	<hr/>
	74

It is identical with a streptococcus isolated from milk coming from cows with mastitis, and is not identical with any other streptococcus tested

The method of culture is best demonstrated by Fig 1 which shows two separate areas of breast carcinoma connected by a lymph-vessel. The organisms are growing from the lymph-vessel. Immediately at operation pieces of tissue are excised and carried down into $\frac{1}{2}$ per cent semi-solid hormone agar. This gives the



FIG 1

necessary partial anaerobiosis and partial tension needed for its growth. It will not grow originally in broth under aerobic conditions.

From all the lesions of the gastro-intestinal tract the cultures were originally streptococci, as shown in Fig 2.



FIG 2

However, from the blood-serum, once from the breast, and in both Hodgkin's glands, the original culture was a diphtheroid, and required repeated transplants to change it to the streptococcus (Figs 3 and 4).

It has been isolated once from a few cells of a tissue culture of mouse carcinoma given to us by Doctor Chambers, the cells isolated and planted

in a droplet of media by the single cell technic (Fig 5) In this case the small granular stage was predominant



FIG 3



FIG 4



FIG 5



FIG 7

When a gastric strain originally a coccus was grown in human blood-serum, gelatin media, the coccus reverted to the first morphological phases

THYROID SECRETION

of the diphtheroid, showing clubbing, parallelism, and granules (Fig 6)

Pathologically, very little, if any, cellular reaction occurs from one inoculation of the organism into animals—best demonstrated by the infected thread passed through the stomach of the dog (Fig 7)

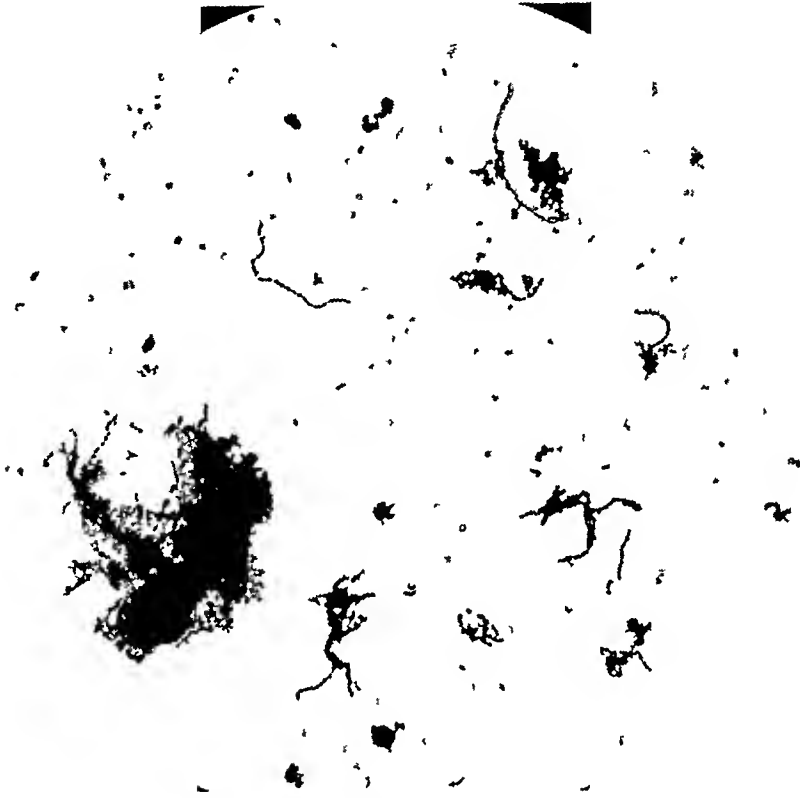


FIG. 6

It does not rule out the fact, however, that given the right morphological phase of the organism, the right environment, and the right lack of resistance of the host, it might be pathological

By showing that all of these morphological forms—bacillus, rod, diphtheroid, coccus and granule—can emanate from the one single cell isolated by the single cell technique, the cultivation of a multiplicity of organisms, as previously believed, is ruled out

Our problem at the present is whether or not the granular stage may possibly exist within a cell without killing the cell

THYROID SECRETION

BY JOHN STAIGE DAVIS, JR., M.D.

OF NEW YORK, N. Y.

THE part played by iodine in various thyroid dyscrasias has been extensively investigated, as to both its source and mode of action while on the other hand the constituent that binds iodine to form the thyroid's active principle, thyroxin, has been almost entirely neglected. The relationship of iodine and the amino-acid, tyrosin, to thyroxin is shown in Fig 1

In the investigation being carried on at present, we are attempting to remove the amino-acid constituent of the molecule. The method of approach

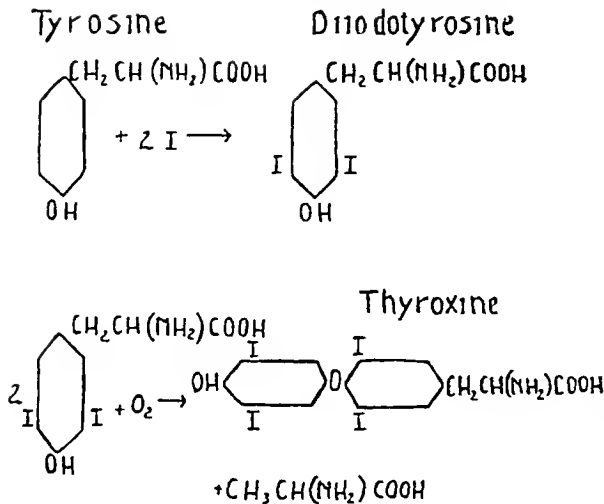


FIG 1—Formation of Thyroxine from Tyrosine

in the gland. That iodine is stored in the gland under these circumstances is shown in Fig 2, taken from Sweet's paper

Groups	Number of Dogs	Iodine of Thyroid mg per 100 Gm Dry Gland		
		Maximum	Minimum	Average
Normals	18	267	0	93.9
Depancreatized	7	992	113	367.8

FIG 2

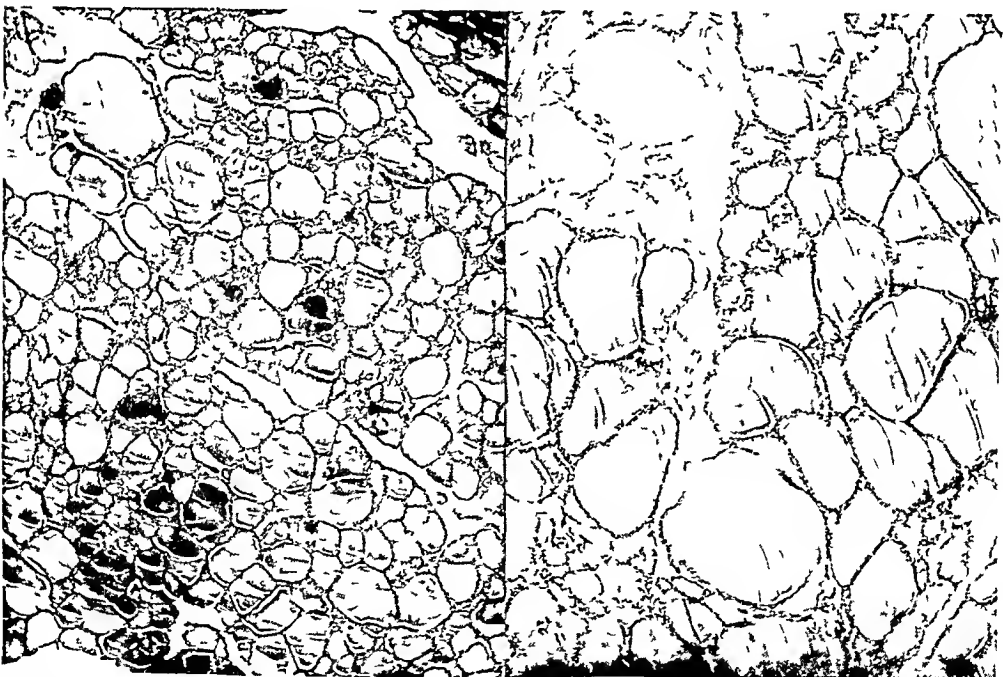


FIG 3

FIG 4

During the past eighteen months experiments have been done in this laboratory on sixty dogs. Various drugs and operative procedures have

FUNCTION OF THE BILIARY TREE

been used to interfere with the supply of the constituents which are used by the thyroid for the formation of thyroxin

Fig 3 is a photomicrograph of a normal dog's thyroid while Fig 4 illustrates a gland six weeks after the dog has had his pancreatic ducts ligated

The conclusions are not definite. If the dogs are fed iodides or if diiodotyrosine is introduced into the vein, they lose weight and die rapidly. The iodine storage in the gland is immense. If the dogs are given thyroxin intravenously they live indefinitely. Tyrosin by mouth will not prolong life.

The chief value of the work is in the presentation of a new method of approach in the study of thyroid disease.

THE FUNCTION OF THE BILIARY TREE

By JOHN E. SUTTON, JR., M.D.

OF NEW YORK, N. Y.

DOCTOR SUTTON presented five lantern slides illustrating the functional relationship of the biliary tree to the gall-bladder.

The first slide, from the liver of a dog forty days after cholecystectomy, showed dilation of an intrahepatic bile-duct with hyperplasia of the epi-

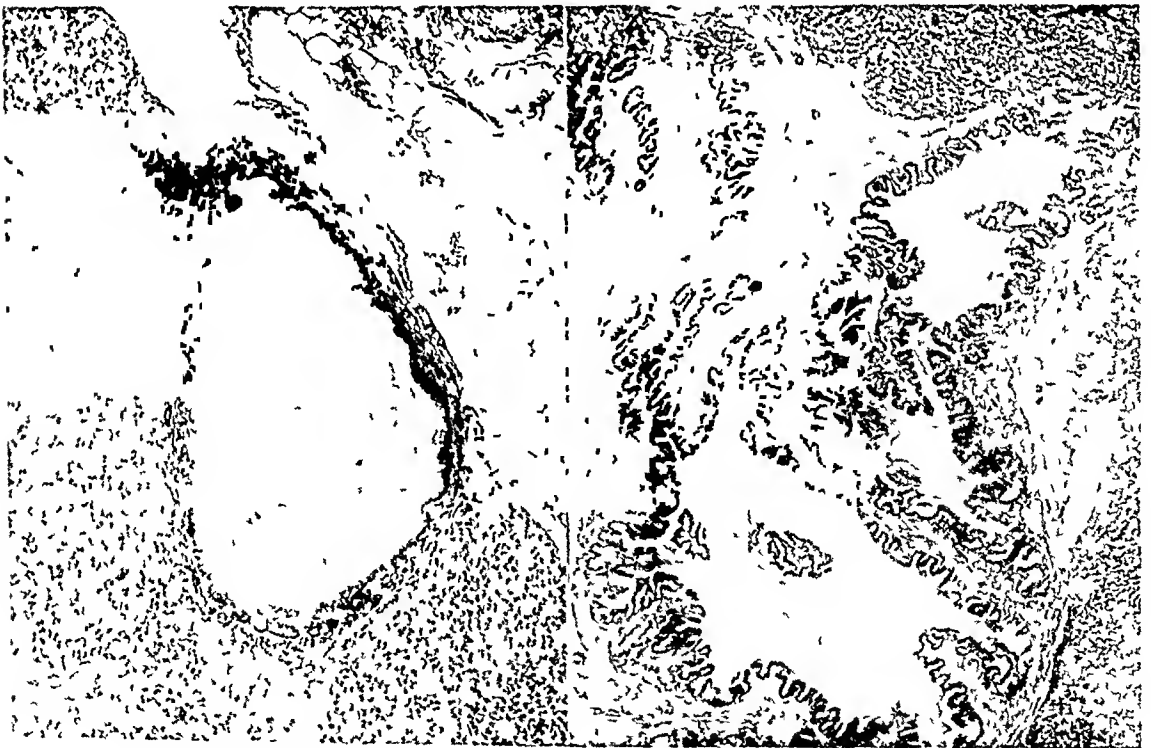


FIG 1—Normal control

FIG 2—Vitamin D deficiency

thelium. The surface of the lumen of the duct was greatly increased by mucosal folds and villi projecting from its surface. Histologically, the cells covering these projections resemble those of the gall-bladder mucosa. (ANNALS OF SURGERY, January, 1930.) These mucosal folds which are found

after cholecystectomy, when stained with Sudan III, are found to be filled with fine droplets of a lipoid after a meal rich in fat. The most important lipoid normally found in the bile is cholesterol or its esters and the examination of frozen sections of these specimens under the crossed Nicol prisms gives suggestive evidence. Such a slide shows large amounts of doubly refractile material in the mucosa and submucosa of the duct projections. Our work suggests that a function of the gall-bladder and the biliary tree may be concerned with sterol metabolism and with that thought in mind feeding experiments have been undertaken. Two groups of newly hatched chicks were used: one, the control group, was fed on a normal diet, and the other was deprived of the antirachitic factor (vitamine D) for the first eight weeks of life. The intrahepatic ducts of the control group showed an almost smooth mucous membrane (Fig. 1) while the ducts of the chicks fed on the deficient diet exhibited pronounced hyperplasia of the epithelium with many folds, villi and septa (Fig. 2). Avian metabolism differs in many respects from that of mammals, and these observations, while suggestive, must be evaluated with caution. Thus far we have not had sufficient material from mammals fed on deficient diets to draw any definite conclusions.

LIVER INSUFFICIENCY

By W. MORRIS WEEDEN, M.D.

OF NEW YORK, N. Y.

THE usual operation of cholecystenterostomy results in a regurgitation of intestinal contents into the gall-bladder with, finally, generalized cholangitis. It was thought that an operation, such as shown in the accompanying schema

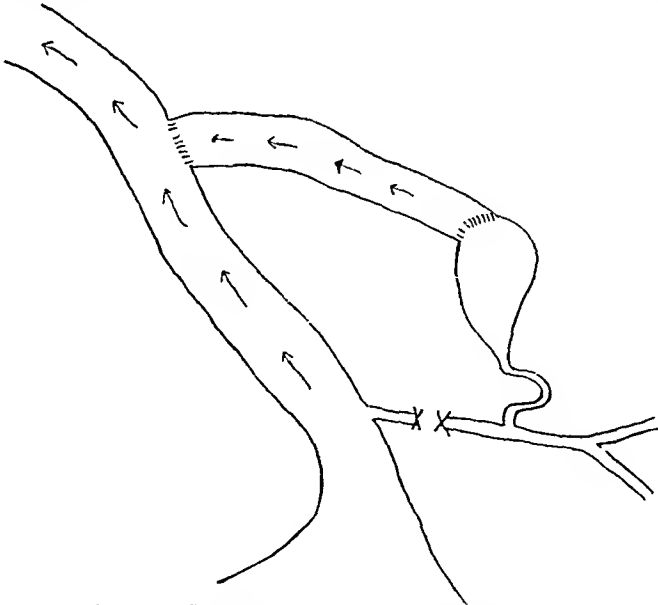


FIG. 1.—Suggestion for improved cholecystenterostomy.

might overcome the entrance of intestinal contents into the gall-bladder by the interposition of a segment of intestine so arranged that its peristaltic

HYPOGLYCÆMIA FOLLOWING HYPOPHYSECTOMY

movements would tend to pass any contents back into the main intestinal current

It was found that the greater number of animals so operated upon died within a short time with every evidence at autopsy that there had been no secretion of bile

Three years ago, having had one of those tragic and sudden deaths following cholecystectomy said to be due to liver insufficiency, I became interested in this subject. Doctor Sweet suggested that some light might be thrown on this condition by repeating his experiment. This I have done in a number of dogs, varying the operation at times by inserting the cut proximal end of the common duct into the intestinal loop instead of making an anastomosis with the gall-bladder. While the results have varied to some extent, yet, in a certain number of cases, death has occurred twenty-four to thirty-six hours after operation. These dogs show very little, other than loss of appetite and high temperature. Autopsy, in some cases, reveals a congestion of the mucous membranes of the duodenum similar to that seen in anaphylactic shock, and a total absence of bile in the liver, intestine and, at times, even in the blood. Apparently in these cases the liver simply stops functioning. It has a dark, congested appearance and in some of the dogs which lived a longer period it becomes almost leathery in consistence.

We are unable to draw any conclusions as yet from these experiments, but expect to continue them and to study the metabolism of the dogs after the operation.

HYPOGLYCÆMIA FOLLOWING HYPOPHYSECTOMY AS AN EXPLANATION OF SO-CALLED CACHEXIA HYPOPHYSEOPRIVA

BY WILLIAM MAHONEY, M D

OF NEW YORK, N Y

THE anterior lobe of the pituitary body has already yielded growth, sex, lactation, thyrotropic and fat mobilization hormones. To study these active principles puppies eight to ten weeks old were hypophysectomized, and this is a preliminary report of a by-product of the original undertaking. It concerns another principle of the probable central control station of the entire endocrine system, and opens a rich vein in the metabolic mine of the carbohydrates.

Clinical evidence has long existed pointing to a pituitary-carbohydrate relationship, and this has been supplemented by a variety of disconnected experimental support. With this present link in the chain it may be predicated that there is a pituitary principle, most likely in the anterior lobe, which plays a leading rôle in the metabolism of carbohydrates, its action antagonistic to insulin.

For many years the debate as to the absolute need of the pituitary body for the maintenance of life was held, the issue being long undecided because of operative difficulties, among other trials. Some animals were finally successfully carried over after proven complete hypophysectomy and the issue was decided. However, the difficulties were not altered and hypophysectomized dogs continued to die of a train of symptoms which Cushing

called "cachexia hypophyseopriva" This state is characterized by a loss of normal interest in the surroundings, irritability, unsteadiness of gait, anorexia, arching of the back, lethargy, fine muscular twitchings, hypersalivation, coma, and death This was the difficulty to be overcome in preparing the puppies for studies which were intended to last for months, for these very symptoms occurred even after the most meticulous operative care checked by absolutely negative post-mortem studies In puppies the symptoms supervened after twenty-four hours, while in the mature dogs the trouble began after a three-day lapse

In observing these happenings repeatedly the syndrome resembled in some points the train of events in humans who have hypoglycæmic crises So, carbohydrate therapy was given to the cachectic animals intravenously, intraperitoneally, subcutaneously, and by stomach tube By whatever method of administration, there was improvement, though after a time symptoms recurred only to be again relieved by more carbohydrates, these alternating states lasting for days To anticipate this difficulty feeding was begun immediately after recovery from anaesthesia, even by stomach tube if necessary, and, if adequate carbohydrates were supplied, "cachexia hypophyseopriva" did not supervene

Blood-sugar studies have demonstrated in puppies that have not been fed post-operatively a normal level for about twenty-four hours, then a rapid fall even to an unreadable content before exitus The early symptoms of mischief manifest themselves at about the fifty milligrams per 100 cubic centimetres level by the Benedict modification of the Folin-Wu method Control puppies fasting for an equal period had no such variations Sugar has never appeared in the urine

That the carbohydrate metabolic disturbance alone is responsible for the old picture of "cachexia hypophyseopriva" we cannot say, nor does it seem reasonable Rather, not alone has the pancreas been given free rein, but all the glands of internal secretion, though perhaps less impressively, are allowed to act without the regulatory influence of the pituitary body However, hypoglycæmia is the likely explanation of fatalities previously attributed to the so-called "cachexia hypophyseopriva"

THE USE OF RIBBON GUT IN THE REPAIR OF KIDNEY WOUNDS

By OSWALD SWINNEY LOWSLEY, M D, AND COURTNEY CRAIG BISHOP, M D
OF NEW YORK, N Y

INCISION of the kidney cortex as a method of providing free access to the renal pelvis, whether for purpose of removal of calculi, or for relief of undrained and infected urine, has been recognized as an acceptable surgical procedure for nearly seventy years The early problem of selection of the site best suited for incision was clarified by the researches of Tuffier and by the anatomical studies of Broedel Innumerable variations in the method

of closure of the wounds were introduced by the reports of many workers describing both experimental and clinical studies

It is commonly accepted that nephrostomy is followed by impairment of renal function, the cause for this has been attributed by some to the incision of functional cortical and medullary tissue and by others to the ischæmia and subsequent scarification of functional tissue peripheral to the through-and-through sutures used for closure of the wound. Deming¹ has supported the latter point of view by demonstrating, by means of corrosion models, that the major damage results from the circulatory changes produced by the through-and-through sutures, variations in the figure of the sutures produced little if any significant difference in the end-result

The investigations described in this report represent an attempt to formulate a technic for closing nephrostomy wounds by means of a flat ribbon laced about the kidney in place of the conventional type of suture which pierces the renal tissue. For such purposes, it would be necessary to have an absorbable flat ribbon of sufficient strength to permit the usual amount of tension to which ordinary catgut is subjected. The ribbon would need breadth in order to produce a definite directed force, which at the same time had no cutting or constricting effect on the renal substance. The material would need to be of such thinness as to permit complete flexibility and ease in handling. These specifications were presented to Davis and Geck, Inc., who developed in their laboratories the ribbon gut used in these experiments.

The suture material so prepared consists of flat ribbons of untwisted gut, 45 to 65 centimetres in length, 18 to 20 centimetres in width and in thickness no more than that of fine rice paper. Sterilized and packed in a manner entirely similar to that of the usual catgut, it remains thoroughly pliable. When exposed to air, however, the material dries rapidly and becomes difficult to handle, moistening with saline solution readily restores its original pliability. The material has been tied after the customary manner and the knots have proven adequate and satisfactory, any tendency for the ribbon to twist on itself has been confined to a matter of a centimetre immediately adjacent to the knot and has in no way interfered with the desired effect, i.e., a broad, flat surface. The manufacturer's *in vitro* experiments demonstrated that the material was absorbable in four to five days.² The *in vivo* experiments conducted in this study have not borne out this finding, the material has been found still intact though of lesser tensile strength, at the end of twenty-three days.

The plan for the present series was to make the conventional type of nephrostomy incision in the kidneys of animals and then close the wounds by encircling the organ with two or three bands of flat ribbon gut. At operation, the closure would be expected to accomplish firstly an adequate approximation of the cut surfaces and secondly complete and permanent hemostasis. Post-operatively, the objective of the experiment was simply to establish whether or not such a procedure was compatible, on the one hand, with life

and continued good health and on the other with satisfactory healing of the organ

The operation itself is neither difficult nor time-consuming. The kidney must be located, completely freed of all adjacent adhesive tissue and delivered into the wound. The chosen site for nephrostomy is located and marked, before the actual nephrostomy is done, however, all preparations for the closure are carefully made. The ribbon gut is looped beneath each pole, adjacent to but not impinging upon the pelvis and its associated vascular pedicle. In the development of the technic, it was found necessary to create some means to prevent the ribbons, when once placed, from slipping lengthwise over the poles of the kidneys. This was accomplished by constructing straps of kidney capsule about three millimetres in width on both surfaces of the viscus at either pole. Through these straps were threaded the free ends of the ribbons, the loop of ribbon was well fixed by this means beneath the pole and the free ends could be readily crossed on the lateral curvature of the organ, *i.e.*, at the site of proposed nephrostomy. After incision through the avascular line of Broedel, closure was accomplished by gently tightening the ribbons about either pole and tying them across the line of incision. A small piece of freshly cut fat introduced into the wound admirably aided in hemostasis. As an added precaution against slipping, the long ends of each ribbon were tied each to the other. When needed to provide thorough hemostasis, a third ribbon was placed in the form of a figure-of-eight about either pole and the long ends crossed and tied over the line of incision. It was found necessary to use this latter figure in only two instances, since in all others the two single ribbons afforded completely adequate closures. When the closure was considered complete the kidney was returned to its fossa and the wound closed without drainage.

The procedure has been carried out in fourteen animals. Originally six rabbits were done and after the method had been found practical in this group, the work was immediately extended to dogs, with which it has since been continued. At the time of writing, ten operations have been performed on eight dogs. There has been but a single fatality, that occurring in a young dog five days after operation, autopsy showed a diffusely suppurating kidney with generalized sepsis. In all the others the wounds have healed *per primam*, without infection and without urinary leakage. The animals have regained or increased their pre-operative weight, and to external appearances have seemed in the best of health. In the dogs there has been a period of toxicity, manifest in loss of appetite and interest, lasting from the second to the fifth post-operative day. The animals have been sacrificed at intervals of two to eight weeks post-operatively, the kidneys were removed examined grossly and prepared for microscopical study. In none was there evidence of old or new hæmorrhage. In all the specimens the nephrostomy has been completely healed, in none has there been distortion of the normal configuration of the organ. The specimens have weighed the same as their respective normal fellows, in none has there been gross evidence of necrosis

nor circulatory damage The suture material (experimental stock No 362) has been found in place and intact up to eight weeks after operation There is relatively little foreign-body reaction imbedding the ribbons

One of us has carried out the procedure in five instances of nephrostomy in human beings Of this group four cases were done for the relief of nephrolithiasis and the other for drainage of a pyonephrosis The operative procedure has been the same as described above In each of these cases the renal pelvis has been drained by a small soft rubber catheter for two to three days, and the renal fossa has been drained by a single folded rubber tissue drain At the completion of the operation the kidney is suspended by the Deming technic³ All these patients have recovered without complications and have experienced a convalescence not at variance from the usual In none has there been secondary bleeding The drains have been removed on the fifth or sixth day and the wounds have been closed and dry by the twelfth day post-operatively

The complete details of this present preliminary study are appearing elsewhere in the near future No effort has been made in this group of investigations to determine the results in terms of the functional efficiency of the kidney, this aspect of the study is to be reported in a subsequent paper The present undertaking has established the fact that closure of wounds of the kidney is technically possible through the use of ribbon gut which is laced about the kidney in such a way as to replace completely the more conventional type of through-and-through suture of catgut The technic of the procedure has been described It has been demonstrated that closure by this method produces satisfactory approximation of the cut surfaces, and also thorough and complete hemostasis It has been further demonstrated that kidneys so repaired heal completely without temporary or permanent urinary drainage, and that such an operation is compatible with a complete and permanent return to health

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THE MUCOSA OF THE GALL-BLADDER

BY JOHN G SCHMIDT, M D
OF NEW YORK, N Y

THE microscopical examination of the mucosal cells of the fresh gall-bladder presents an unusual picture More than fifty years ago, Virchow, in the study of fresh teased specimens of gall-bladder mucosa described the cells as being filled with refractile globules which he considered to be fat in the process of absorption With the development of modern pathological

technic, involving the fixing and staining of tissues with solutions composed largely of fat solvents, this picture was lost and its possible significance forgotten

The technic used is simple and consists merely in picking a minute piece of the mucosa and placing it in a weak formalin solution under a cover slip, a few gentle taps on the cover slip serve to break up the tissue so that individual cells may be made out. There was then shown a lantern slide, obtained from the gall-bladder of a healthy dog, which, for three days previous to the operation, had been given a daily half pint of heavy cream, in addition to his regular diet, he was then killed with ether inhalation and the gall-bladder immediately removed. This organ appeared, grossly, to be entirely normal, the mucosa however, having a somewhat milky appearance, most marked, at the ampulla and in the cystic duct. The slide was immediately made in the manner just described, and adequately shows the globules packing the cytoplasm of a row of mucosal cells. Another slide is the same field with the Nicoll prism attachment, giving the affect of doubly refractile material with polarized light. The "Maltese Cross" effect produced by some of the globules, which is believed by many to indicate the presence of the cholesterol esters, can be made out

Fresh human gall-bladders obtained at operation have also been examined by this technic and pictures approximating this were seen, especially in those presenting grossly the so-called "strawberry" or cholesterosis appearance.

What the exact implication of this is, we are not prepared to say. We have revived these old observations merely as evidence of an active rôle, possibly that of fat absorption, being played by the epithelium of the gall-bladder, and we offer this as a small contribution to the present knowledge of the function of the gall-bladder.

THE FORMATION OF GALL-STONES

BY JOSHUA E. SWEET, M.D.

OF NEW YORK, N. Y.

I AM convinced that the gall-bladder has a function other than that of a mere reservoir for bile. When one finds such a complex valvular arrangement in the cystic duct as is formed by the valves of Heister, it is difficult to think otherwise than that such a device is designed to prevent emptying, and when one studies the extremely complicated arrangement of the mucous membrane, one must feel that the organ is designed for absorption. The work presented by Doctor Schmidt is, to my mind, proof that the gall-bladder cells are concerned with some active process in lipoid metabolism. The work which Doctor Sutton has shown points, we believe, to a compensatory hypertrophy throughout the biliary tree, after removal of the gall-bladder, and the second part of Doctor Sutton's work suggests that the real function of the biliary tree may be connected with the metabolism of sterols, or, more specifically, vitamin D. On the basis of such an hypothesis, the gall-stones which are composed mainly of cholesterol may represent a disturbance in vitamin D metabolism, a disturbance comparable to the formation of kidney stones when the vitamin A metabolism is upset.

If the gall-bladder is an organ of absorption, gall-stones may form under

either of two circumstances. The absorbing membrane may be destroyed, as is often found in the association of chronic cholecystitis and cholelithiasis. Infection is, however, not necessary to the formation of stones as is shown by the finding of chronic cholecystitis without stones, and, conversely, the finding of stones in a perfectly normal gall-bladder.

This latter finding—stones in a normal gall-bladder—I believe is to be explained on the hypothesis that the material furnished to the gall-bladder by the liver is pathological, that is, nonabsorbable, and, therefore, it must collect.

How, then, does cholecystectomy cure cholelithiasis? In the case of chronic cholecystitis with cholelithiasis, obviously, by removing the cause and effect. In the case of cholelithiasis of liver origin, I believe the good effect of cholecystectomy can be explained only by the secondary effect of cholecystectomy upon the anatomy and the function of the duct system. The normal bile-ducts become enormously dilated after cholecystectomy, and through this widened tube the pathological liver product escapes into the intestine, and, whereas bile normally flows into the intestine practically only during the periods of active digestion, after cholecystectomy it dribbles constantly into the intestine, *i e*, there is no opportunity for collection and precipitation. But this has not cured the basic trouble, *i e*, the metabolic upset in the liver.

But I suspect this does not always happen and I am convinced that this failure to obtain free drainage after cholecystectomy is the real explanation of common-duct stones following cholecystectomy.

There is a type of common-duct stone which is composed of a dark brown mass of pigment and salts which is characterized by its tendency to break into many fragments on drying. I suspect that the explanation of this type of stone is to be sought in the anatomical relationships between the bile-ducts and the pancreatic duct. A stenosis at the common opening in the normal arrangement of bile and pancreatic ducts would cause a mixing of the two secretions within the duct system which might readily produce a precipitation of the salts and pigments of both secretions.

Under such circumstances cholecystectomy might produce a cure as it apparently did in one case from which I obtained the stone, but in another, which I owe to Dr. Guildford Dudley, and which I trust he will bring before the Surgical Society at some future date, a cholecystectomy was done, a second operation was performed for common-duct stones, and, finally, Doctor Dudley removed a remarkable structure from the common duct, a cast of the right and left hepatic ducts, the common hepatic duct, the stump of the cystic duct, and the beginning of the common duct. Manifestly the accepted surgical procedure, cholecystectomy, was not curative in this case. I believe that surgery must devise some other procedure to meet this particular condition of common-duct stones.

MEMOIRS

HARVEY GILMER MUDD

1857-1933

DR HARVEY MUDD was born in St Louis in 1857 His father was Henry Thomas Mudd, a man of affairs, his mother, Sarah Elizabeth Hodgen, a sister



(Strauss photograph)

HARVEY GILMER MUDD M D

of the distinguished surgeon, John T Hodgen There were two brothers, Henry H Mudd and Seeley W Mudd The former, who was older, became a distinguished surgeon, the other a distinguished mining engineer There were

two sisters Fannie, who died after graduation at Monticello, Illinois, the other, Elizabeth, married Doctor Lemen of Denver Colorado. All the family enjoyed the opportunity of a thorough education. Harvey's family moved to Kirkwood in his second summer because of his health, and he attended school in this cultured suburb of St. Louis, later commuting to the city for his high school work. After graduation from Central High he entered Washington University where he took two years of academic work, leaving there in 1878. His uncle, Doctor Hodgen, was at the zenith of his most distinguished career and his brother, who was engaged in practice with Doctor Hodgen, had already made a name for himself.

As might have been expected Doctor Mudd then entered medicine, enrolling in the St. Louis Medical College where his uncle was dean and his brother a professor and he graduated in 1881 in the first class under the three year curriculum. He then entered the St. Louis City Hospital as an intern and also took part of his service at the Female Hospital, which completed the year 1881-1882.

In the St. Louis Medical College he became a demonstrator of anatomy in 1888, then a lecturer on osteology, and later professor of osteology and regional anatomy. He was professor of fractures and dislocations for several years, up to the time of the union of the St. Louis Medical and the Missouri Medical Colleges in 1899. Then he became professor of clinical surgery but after the combination he did less teaching than formerly. When the reorganization of the school took place in 1909 Doctor Mudd remained as professor of clinical surgery, and at his death he was Emeritus in Surgery.

After returning to St. Louis from abroad in 1887 where he had spent two years studying in Vienna, Berlin, Paris, London, and Edinburgh, he started in practice with his brother, Henry Mudd, rising to a position of prominence on sure and certain steps. While they had work all over the city their chief activities were centered about St. Luke's Hospital where the elder brother was chief of staff, and on his death in 1899, Harvey Mudd was elected to this place which he ably filled for thirty-three years up to his death. St. Luke's Hospital remained throughout his life his chief interest, he being not only chief of staff, but chief surgeon and a member of the board of directors. His constant interest and careful direction were responsible for the fine development of the institution. St. Luke's showed his influence in every department and whatever success it has obtained is largely due to his cooperation. There was no activity in the hospital that he didn't have a voice in. Here he did most of his surgery, and it was in the practice of surgery that he made his greatest name.

He had a keen ability at diagnosis and a training in clinical medicine and surgery that made him a most helpful consultant. He was among the first to do extensive breast operations and his fine results gave him a large clientele in this class of cases. In abdominal surgery he had his greatest successes and he carefully followed the advances in this field so that he was always among the leaders. It is hardly fair to stress any branch of surgery as his special favorite.

because he was essentially a general surgeon, taking as much pride in the excellence of his thyroid work as he had satisfaction from his skill in handling fractures, particularly those about the hip and thigh, where he could use better than anyone else the Hodgen splint that he had learned so well how to apply from his inventor uncle, Doctor Hodgen. He gave considerable attention to genito-urinary surgery in the earlier days of this specialty and was a member of the Association of Genito-Urinary Surgeons of America from the year 1899, and its president in 1908. He was a member of the American Surgical Association and its vice president in 1920. He took a keen interest in the St. Louis Surgical Society from 1903 until his death. He also had membership in numerous scientific societies, the St. Louis Academy of Science, the Archaeologic Institute, the International Surgical Association, the Society of Physico Chim de Palermo. He was an active supporter of the St. Louis Medical Library from its inception up to the time it was taken over by the St. Louis Medical Society. He was also a member of the College of Surgeons.

In 1892 Doctor Mudd and Miss Margaret de la Plaux Clark were married. The son, Stuart Mudd, was born in 1893. He now lives in Philadelphia where he is associate professor of experimental pathology in the University of Pennsylvania. Mrs. Mudd and Dr. Stuart Mudd were with Doctor Mudd when he died in Boston, after a prostate operation, on August 16, 1933.

Few men started their practice with the advantages that Harvey Mudd had, and few careers have fulfilled the promises of their auspicious beginnings better than did his. Under the fortunate aegis of his family tradition, and endowed with a physique that made it possible to labor endlessly, his alert acquisitive mind gathered knowledge and experience, and his fine personality made him sought for and developed in his patients a devotion that was an adulation. His spirit was that of a youth, it never grew old. He enjoyed people, if they were his friends, with a zest that is rarely equaled, and it is easy to understand why since his death one man wrote, "He was a wonderful man, full of human sympathy and loved by more people than any other man in St. Louis."

He was passionately fond of the outdoors, taking part in hunting expeditions with the keenest zest. His love for the country urged him to get a small place in the foothills of the Ozarks where he could raise turkeys and guinea fowls and some wild birds, a bird sanctuary in fact, and here he spent much of his spare time in the last few years. He had a great fondness for music and in his later years was a regular attendant at the symphony concerts, though he equally enjoyed the less classical forms of music. At his own home he was seen at his best, an ideal husband, parent and friend, always seeking to advance the pleasure of those dear to him, and his fund of good stories, always kindly, made him welcome and spread sunshine wherever he went. As President Williams of Missouri University wrote, "He was a credit to his City, his State and to his Country."

M. B. CLOPTON

GEORGE DAVID STEWART

1862-1933

GEORGE DAVID STEWART was born December 28, 1862, in Cumberland County, Nova Scotia, of Scottish descent. He brought traditions from both these sources to this country, where he began his medical education in 1886



GEORGE DAVID STEWART, M.D.

at the Bellevue Medical College, now the Medical Department of New York University, from which he was graduated in 1889. It was in connection with this college that he expended the greater part of his abundant energy and

industry during the remaining forty-four years of his life. He still held the position of Professor of Surgery, to which he was appointed in 1914, at the time of his death March 9, 1933. He became a Fellow of the American Surgical Association in 1915.

Stewart's greatest contribution to surgery was as a clinical teacher. He had, to an unusual degree, the power of clear and forceful expression so that the weekly operative clinics which he held in the amphitheatre at Bellevue Hospital for nearly thirty years were enthusiastically attended by his students, as well as by large numbers of visitors to the hospital.

His devotion to teaching and his real ability as an organizer of a surgical department along practical lines resulted, in 1930, in the creation of the amply endowed George David Stewart Chair of Surgery at his Alma Mater by a life-long friend, the late Mr. George F. Baker.

Doctor Stewart was a firm believer in the modified form of didactic teaching and under his leadership and influence such teaching had great value. The utilization of a municipal hospital for teaching purposes with university ideas is always fraught with administrative difficulties. In cooperation with the late Dr. William M. Polk, Dean of Cornell University Medical College, and Dr. Samuel Lambert, Dean of the College of Physicians and Surgeons, in developing Bellevue Hospital along these lines, Doctor Stewart illustrated one of his strongest characteristics—an ability to gain public confidence and turn it to public advantage.

He received the unusual honor of being elected for three successive terms to the Presidency of the New York Academy of Medicine. During his tenure of office, from 1919 to 1925, he carried forward developments in building and administration which placed that Institution in a position of leadership not only in this community but throughout the state and, to some extent, the country. His influence certainly was national. In 1927 he was elected President of the American College of Surgeons, which office he administered with great ability. His writings on surgical subjects in the clinical field were frequent and were characterized by a clear-cut manner of expression which placed emphasis where needed.

No sketch of the life of George Stewart would be adequate that did not include a reference to his love of literature, particularly poetry, and to other forms of art. He was a constant reader of the classics and, being endowed with an excellent memory, he delighted many audiences with apt quotations and anecdotes. He was a writer of verse of no mean merit. His ability as a speaker was widely recognized so that he was in constant demand on serious occasions and others less serious.

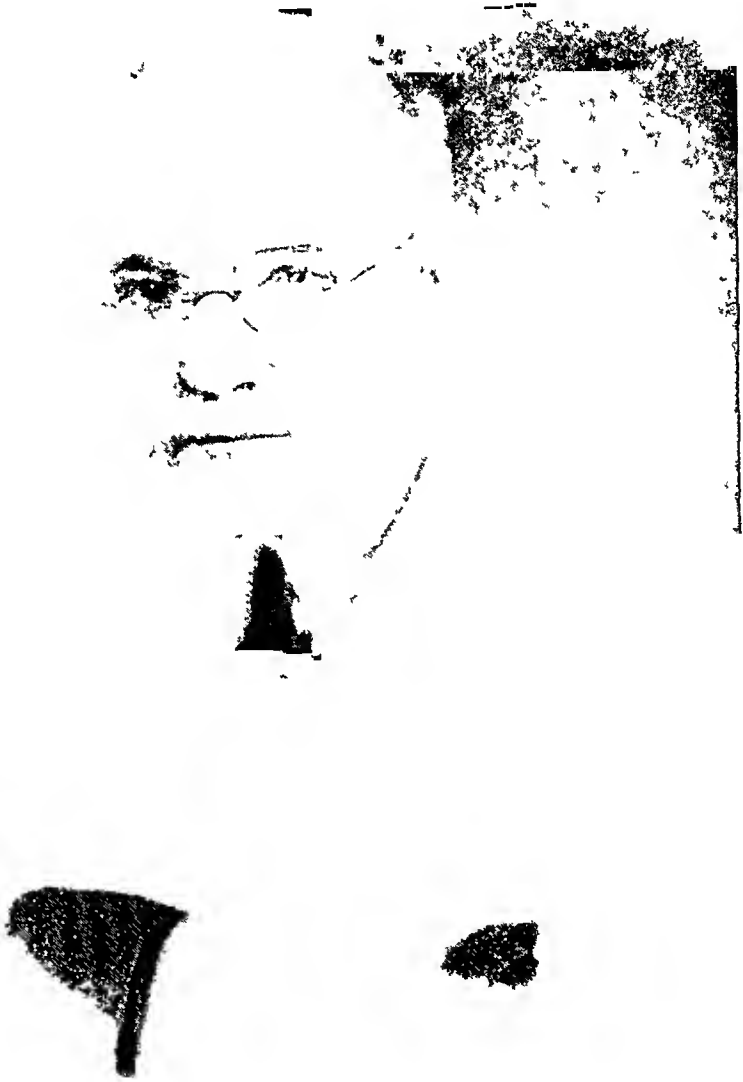
The Academy of Medicine, in mourning his death, bore testimony to the loss of a "forceful leader and teacher, a wise counselor, a kindly man and a dear friend. With his magnetic personality, his rare gift of humorous expression and his wisdom acquired through wide experience, he was a dominant figure among his fellows."

JOHN A. HARTWELL

JOHN SPEESE

1880-1933

THE Philadelphia Academy of Surgery has seldom been called upon to record the loss of its President during his term of office. Doctor Speese had several months still to serve when October 15 he died suddenly. He was a victim of coronary sclerosis—the “doctors’ disease”—entirely unsuspected



JOHN SPEESE, M.D.

until his first attack a few weeks before. Only fifty-four, he seemed in full vigor and entitled to expect many years of work and reward. He was always a hard worker, never taking long vacations. The last year had been a particularly difficult one for him, bringing with it much hard work and an unusual degree of worry and strain. These factors were probably responsible for the acute development of his fatal disease.

Doctor Speese trained himself wisely, combining laboratory and clinical work in proportions that made him a well-rounded surgeon. As a result, his judgment in gross and microscopic tumor diagnosis was greatly sought after and valued. He was an excellent and safe operator, bold if need be, never rash. He understood the art as well as the science of surgery and his patients profited thereby. He was a helpful consultant, he had an analytical mind, quickly reaching the heart of the problem. His advice was sound, constructive and clearly expressed.

Well prepared by such experience, he was one of the many surgeons of America who offered their services to their country in the World War. Owing to changed needs, his unit was broken up soon after landing in France. Uncomplainingly he accepted unimportant assignments until he was made head of an operating team with Mobile Hospital 2. After an arduous term of service there, he was transferred to Mobile Hospital 8 as Chief Surgeon. Here his worth as surgeon, executive and man was widely appreciated. Returning home, he was one of those who rapidly came to the front, being rewarded by important hospital positions and memberships in national societies. He contributed articles to current literature and monographs to other publications.

From an experience of nearly thirty years in many places and relationships, the writer wishes to pay a tribute to Doctor Speese as a friend. He enjoyed companionship, he was a good mixer, he had a keen sense of humor and a faculty for analyzing people and things and summing them up in a pithy remark. These and other qualities made him a welcome member of many a circle.

EDWARD B. HODGE

EDITORIAL ADDRESS

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JEJUNAL ULCER

SOME OBSERVATIONS ON ITS COMPLICATIONS AND THEIR TREATMENT

BY D P D WILKIE, M Ch, F R C S

OF EDINBURGH, SCOTLAND

PROFESSOR OF SURGERY IN THE UNIVERSITY OF EDINBURGH

THE problem of jejunal ulcer is one of real, if somewhat melancholy, interest to the surgeon. It is one of his own producing and is admittedly difficult of solution. The operation of gastrojejunostomy, at one time regarded as one of the most beneficent of surgical procedures, is now considered by many surgeons as an unjustifiable measure in the treatment of peptic ulcer. On the Continent of Europe gastric resection has largely replaced the short-circuiting operation, but in Britain and in America opinion has not swung over to the more radical practice, at least in the treatment of duodenal ulcer.

Jejunal ulcer is unquestionably a serious condition and prevention is simpler than cure. Briefly stated, it occurs more frequently in men than in women, and is much commoner after gastrojejunostomy for duodenal ulcer than it is after the same operation for gastric ulcer. Its incidence is variously stated at from 2 per cent to 40 per cent by different writers, and it would certainly appear to be commoner among the Teutonic and Semitic races than among those of Anglo-Saxon stock. Whilst it is difficult to give accurate figures regarding a condition which is not always confirmed by operation, my own figures show the incidence to be approximately 3.5 per cent of all gastrojejunostomies for ulcer. Further, it appears to occur much more frequently in patients who, before operation, had a high gastric acidity and little gastric retention. It occurs but rarely in patients with old-standing pyloric or duodenal stenosis and with low gastric acidity. It was in the treatment of the latter type of case that the reputation of the operation of gastrojejunostomy was founded, and had it been restricted to this type the problem of jejunal ulcer would not be the burning one it is to-day.

In my experience the most effective preventive measure is to avoid a gastrojejunal anastomosis in all cases of duodenal ulcer with high acidity and little or no stenosis and to employ either gastroduodenostomy or some form of plastic operation at the pylorus in such cases. As infection is another factor in the etiology, the eradication of septic foci in teeth, tonsils, appendix and gall-bladder should form an essential part of therapy in ulcer cases. Further, the injudicious or heavy-handed use of clamps in the operation of gastrojejunostomy may determine an area of lowered vitality which may fall a prey to the acid chyme in the early post-operative period.

The tendency to regard the operation as the cure rather than as an incident in the treatment of peptic ulcer, with consequent failure to insist on care in diet and to exhibit alkalies during the early months of convalescence, is still all too common. The sensitive jejunum must be sheltered from hyperacid gastric juice till such time as it has acquired immunity, and any neglect to observe this reasonable precaution must inevitably lead to a high incidence of jejunal ulcer.

Pathology—The distinction between gastrojejunal and jejunal ulcer is more of academic than practical interest. The suture alone will not determine an ulcer and, whilst devitalization at the suture line must of necessity play a part when the other ulcer-determining factors are operative, it is common knowledge that the ulcer is just as common at some distance from as on the line of suture. We may, therefore, consider the two types of ulcer as essentially one and the same. My experience leads me to believe that in the majority of cases the onset of jejunal ulcer follows hard on the operation although the recumbency and the initial care in diet, which characterize the immediate post-operative period, may to some extent mask the symptoms. Certainly it is true that the patient who complains of acidity and heartburn during the early post-operative stage is a strong candidate for the ranks of jejunal ulcer cases.

Apart from the persistent dyspepsia which is the common lot of sufferers from jejunal ulcer, certain alarming and disabling complications are frequently encountered. Some of these I will but mention, others I wish to deal with in greater detail.

Recurring hæmorrhage is the most frequent and the most difficult to treat. It calls for surgical treatment preceded by blood transfusion.

Perforation into the free peritoneal cavity, whilst uncommon, is always serious owing to difficulties of satisfactory closure without compromising the gastrojejunal outlet. If the immediate dangers are survived, a second operation, to treat the ulcer, is usually required and presents a formidable technical problem.

Subacute perforation with the formation of an inflammatory mass, situated to the left of the umbilicus, calls for conservative treatment until such time as the inflammatory reaction has subsided. Thereafter surgical interference must be undertaken. If the local conditions permit, the region of the anastomosis must be freed and a partial gastrectomy performed. When the patient's general condition is poor, and inflammatory infiltration of the mesocolon and root of the mesentery is such as to present formidable obstacles to a safe resection, I have found that reasonably good results follow a double short-circuiting operation, *viz.*, a gastroduodenostomy to exclude the old ulcer, and a duodenojejunosomy to exclude the region of the jejunal ulcer.

Penetrating Jejunal Ulcer—It is usual to find the ulcer just at the stoma, alongside it or just beyond. Occasionally, however, the ulcer may be found in the jejunum proximal to the stoma. In such cases it may penetrate into the mesocolon and the posterior abdominal wall, just as a posterior gastric ulcer penetrates into the pancreas. Excision of such a penetrating ulcer may

lead to a wound of the superior mesenteric vein and it should not be attempted. In a very pronounced example of such an ulcer in the proximal loop, a completely satisfactory result followed the removal of the gastroenterostomy stoma, closure of the stomach and the jejunum, the establishment of a gastroduodenostomy opening to exclude a stenosing duodenal ulcer, and a duodenojejunostomy to short-circuit the jejunal ulcer.

Secondary Duodenal Ileus—I wish to draw attention particularly to the occurrence of duodenal stasis as a factor in both the pathological and clinical pictures of many cases of jejunal ulcer and especially cases of long standing. The tendency to thickening and fibrosis in the region of the stoma leads, on the one hand, to a gradual narrowing, and in some cases a potential, if not actual, occlusion of the gastroenterostomy opening, and, on the other hand, to an inflammatory induration of the root of the mesentery which interferes with the efflux from the duodenum. In the treatment of such old-standing cases special measures must be taken to drain the partially obstructed duodenum if complete relief is to be gained. In some cases drainage of the duodenum by the establishment of a duodenojejunostomy stoma may be all that is necessary, in others this operation must be associated with a direct attack on the jejunal ulcer and the original stoma.

The following two cases illustrate this point. They represent extreme degrees of the factor of duodenal obstruction, a factor which in minor degree is present in a large number of cases.

CASE I—A M., aged sixty-two. Twenty-five years ago had a gastrojejunostomy done for duodenal ulcer. He was well for some years then he began to have recurring attacks of indigestion and on two occasions had melæna. For the past ten years has had increasing discomfort after food, great flatulence and occasional vomiting of large quantities of fermenting bile-stained fluid. For the past five years has been in the habit of passing a stomach tube daily and washing out his stomach. Every now and then he would get attacks of pain and distention. He had to eat very sparingly and consequently had slowly but steadily lost weight.

On examination a large splashing stomach, and what was taken to be a splashing duodenum, were made out. A barium meal examination showed nothing passing through the stoma, great retention in the stoma and a mega-duodenum with great retention in spite of active writhing peristalsis (Fig 1).

A diagnosis of jejunal ulcer, with stenosis of the stoma and pronounced secondary duodenal ileus, was made and operation with a view to draining the dilated duodenum recommended.

Operation—A mass of fibrous tissue surrounded the area of the stoma, which was bound down over the root of the mesentery, and tightly stenosed. The first part of the duodenum showed the scar of an old ulcer but no stenosis. The duodenum in its second and third parts was greatly dilated and hypertrophied. There appeared to be no indication to interfere with the old stoma and accordingly a duodenojejunostomy was performed. He made a most rapid and gratifying recovery, lost all distention, regained his appetite and put on twenty-eight pounds in weight in the following three months.

In a weakly and emaciated individual, over sixty years of age, a direct attack on the site of the old ulcer would have been both meddlesome and dangerous. In this case the duodenal ileus had gradually come to dominate

the clinical picture and the one essential part of the surgical treatment was to drain the obstructed duodenum

CASE II—J F, aged fifty-six. Twenty-two years before had a gastrojejunostomy done for "dyspepsia" no ulcer was seen at operation. Patient was never quite well following the operation and developed symptoms of jejunal ulcer some five years before the second operation. One day patient was seized suddenly with a very acute abdominal pain, suggesting a perforation. He was treated on conservative lines



FIG 1—Gross duodenal ileus resulting from long standing jejunal ulcer. Complete relief followed duodenojejunostomy

Radiograms taken two weeks later showed that the barium was leaving entirely by the pylorus and that there was pronounced duodenal stasis (Fig 2)

At operation there was induration and congestion round a narrowed stoma, and a dilated and hypertrophied duodenum bulged beneath the transverse mesocolon. The first part of the duodenum was dilated and showed no trace of ulceration. The stoma was freed, the opening in the stomach closed and the rent in the jejunum closed transversely. A submesocolic duodenojejunostomy was then performed. In spite of a stormy convalescence the patient made an excellent recovery and is now well.

JEJUNAL ULCER

These two cases show in pronounced degree the development of chronic duodenal ileus as a result of jejunal ulceration. Minor degrees of the condition are more frequent and if demonstrated by X-ray examination should determine the establishment of duodenal drainage as one essential step in whatever operative procedure is adopted. Failure to overcome duodenal stasis will lead to persistence of discomfort and may, if the gastroenterostomy has been simply removed, lead to a recrudescence of duodenal ulcer. The



FIG. 2—Duodenal ileus associated with jejunal ulcer. Complete relief followed removal of stomach and duodenojejunostomy.

following case, although not a true example of jejunal ulcer, illustrates the point in question.

CASE III.—J. P., aged twenty-eight, after some months of symptoms of duodenal ulcer, was seized with sudden abdominal pain, typical of perforation. He was operated on some hours later and a perforated ulcer of the duodenum exposed. The perforation was closed and a posterior gastrojejunostomy performed. After doing well for some days he commenced to vomit bilious material, and this continued for ten days during which time he became progressively weaker and developed generalized tetany.

He was given a barium meal and X-ray photographs taken, when it was seen that

the barium was leaving entirely by the pylorus and was held up in a greatly dilated duodenum

A second operation was performed, at which the jejunum was detached from the stomach—*restitutio ad integrum*. The patient convalesced slowly and, although suffering from some indigestion and flatulence, was able to return to work. After some months duodenal ulcer symptoms returned, worse than ever before, and continued in spite of medical treatment.

Seen two years after his first operation, he was in poor health and suffering from persistent pain and flatulence.

X-ray examination showed that he had a large duodenal ulcer and marked stasis in a dilated duodenum (Fig 3).

An operation to short-circuit the duodenal ulcer and to drain the dilated duodenum



FIG 3—Chronic duodenal ileus persisting after removal of stoma with recrudescence of duodenal ulcer. Gastroduodenostomy and duodenojejunostomy gave immediate relief.

was recommended. This was carried out. It was found that in the first coil of jejunum and over the root of the mesentery there were thickening and fibrosis. A gastro-duodenostomy to exclude the first part of the duodenum, and a duodenojejunostomy to drain the duodenum, were performed.

The patient was immediately relieved of all his former symptoms and made a rapid and complete recovery.

In this case the conditions were exactly comparable to those found so often in jejunal ulcer cases, and the two-fold anastomosis which was made is the operative measure which can be carried out with comparative safety and success in such cases.

A Jejuno-colic or a Gastrojejunocolic fistula—This is always of grave import. The regurgitation of fecal matter into the stomach destroys all appetite for food and leads to characteristic anæmia, and the entry of par-

tially digested food into the colon causes persistent diarrhoea and loss of weight. (Fig 4) The stomach content is foul and septic and all endeavors to clean the stomach by lavage merely accentuate regurgitation of feculent fluid

Operation under such conditions is always fraught with serious risk to life. The region of the fistula is found engorged and oedematous the lymph-vessels leading from it are infected, and a clean resection is well-nigh impossible. The mortality from one-stage radical operation is very high (almost 40 per cent). Where the fistula is small and the general condition of the patient has not been allowed by delay to deteriorate a one-stage operation freeing and closing the colon and dealing with the jejunum by resection, possibly followed by partial gastrectomy, may be feasible. In the majority of cases, where the patient's general condition is poor, I believe that a two-stage operation is advisable.

The following case of gastrocolic fistula revealed to me the advantages of a two-stage procedure.

CASE IV—M. C., aged thirty-two. Troubled with stomach for ten years. Periodic attacks of pain coming on one hour after meals, associated with much flatulence and frequently accompanied by vomiting. For two years prior to admission the pain had been more persistent than ever before. Six months before coming to hospital he was awakened in the night with severe abdominal pain. He vomited on several occasions and noticed that the vomit was dark brown in color and feculent in odor. The pain lasted for twelve hours. It was diagnosed as being due to appendicitis and he was removed to his local hospital where his appendix was removed. During the five weeks he was in hospital he had constant feculent-smelling eructations. For six months thereafter he steadily lost weight from absence of appetite and persistent diarrhoea. The foul eructations made him shun company and live by himself. The patient was thin and emaciated. Pale with a tinge of cyanosis in lips, cheeks and ears. Nothing to be made out on abdominal palpation.

Barium meal and barium enema showed large fistula between stomach and splenic flexure of the colon. (Fig 5)

First Operation—August 27, 1931. Gas and oxygen. Left paramedial incision. Fistula round between posterior wall of stomach near lesser curve and splenic flexure of colon. In the area of the fistula both stomach and colon were greatly congested and oedematous and there was a considerable amount of fluid content in both viscera. It was deemed inadvisable to detach the colon from the stomach where both were fixed, infected and oedematous, and it was decided to exclude the portion of colon involved in the fistula. Accordingly the phrenicocolic ligament was divided and the splenic flexure mobilized. The colon was then divided by the cuff method three inches proximal and again three inches distal to the fistula. The ends of this isolated loop were then ligated and invaginated. An end-to-end anastomosis, with one row of interrupted linen sutures over clamps, was then performed to re-establish the continuity of the colon. (Fig 6) To minimize the risk of leakage a tube cæcostomy was performed. The patient made a rapid recovery.

Eleven weeks later patient was readmitted. He appeared to be in robust health. He had put on twenty-nine pounds in weight and had lost his anæmia.

X-ray examination showed a penetrating ulcer opening into the attached loop of colon.

Second Operation—November 16, 1931. The loop of colon was found with dif-



FIG 5—Gastrocolic fistula resulting from perforation of large gastric ulcer into splenic flexure. Opaque enema shows barium entering stomach.

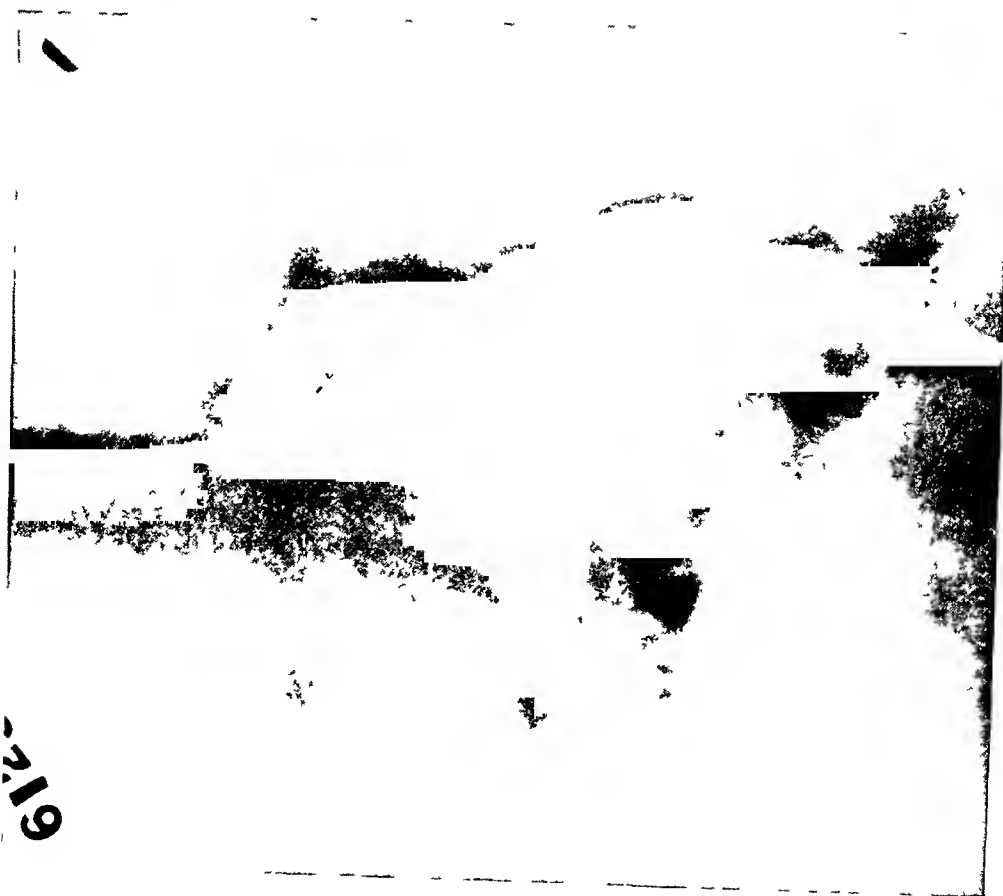


FIG 4—Gastrojejunal fistula. Immediately after meal. Barium seen in dilated jejunal coil and transverse colon.

JEJUNAL ULCER

ficulty, buried in adhesions. It was practically empty and was pale in color. The loop was readily excised along with the gastric ulcer, and a portion of gastric wall around it.

Patient made a rapid recovery and has remained in good health.

I believe that the two-stage method practised in this case is the method of choice for the larger gastrojejunocolic fistulæ, where marked fecal regurgitation is occurring, where the patient is anæmic and all the tissues around the fistula are œdematous, friable and infected. By excluding the portion of colon involved in the fistula, and allowing a period of some weeks or months to elapse, a relatively clean field can be obtained for the second and major stage of the operation.

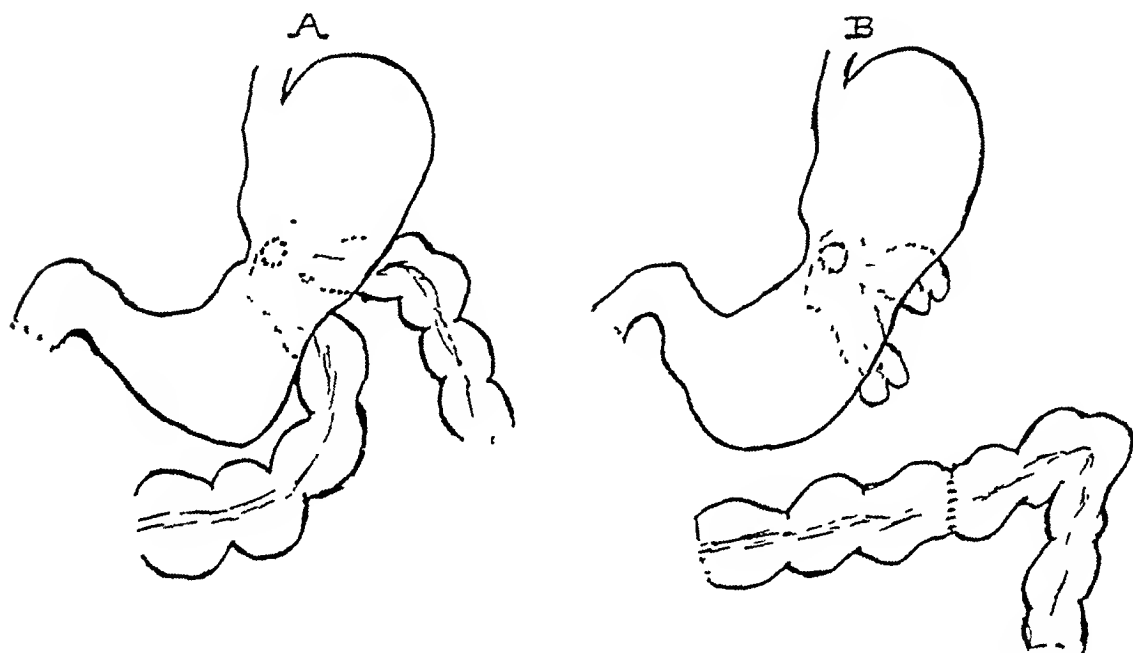


FIG 6—(A) Gastric ulcer perforated into splenic flexure. Gastrocolic fistula. (B) Portion of colon isolated, end to-end union re establishing continuity.

SUMMARY

(1) The two main factors in producing jejunal ulcer after gastroenterostomy are high gastric acidity and infection.

(2) A very high gastric acidity should be regarded as a contra-indication to gastroenterostomy—a gastroduodenostomy should be preferred.

(3) All septic foci in teeth, tonsils, appendix and gall-bladder should be dealt with in ulcer cases.

(4) Partial gastrectomy or removal of the stoma, followed by gastroduodenostomy, are the operations of choice in jejunal ulcer.

(5) The frequent occurrence of secondary duodenal ileus and the necessity for treatment of this by duodenojejunostomy is emphasized.

(6) In dealing with cases of jejunocolic or gastrojejunocolic fistula, the advantages of a two-stage operation should always be considered.

OSTEOCHONDRITIS DISSECANS

INTRA-ARTICULAR OSSEOCARTILAGINOUS LOOSE BODIES

A CLINICAL STUDY BASED UPON TEN PERSONALLY OBSERVED CASES

BY FRANCIS M. CONWAY, M.D.

OF NEW YORK, N. Y.

FROM THE SURGICAL SERVICE OF THE HARLEM HOSPITAL, DR. JOHN F. CONNORS, DIRECTOR

OF THE various joint conditions grouped under the term "internal derangement" due to loose bodies, that of osteochondritis dissecans is among the most unusual and interesting. The entity, whose obscure and confusing etiology is emphasized by the variety of synonyms used to describe it, is defined as a non-infectious process involving the articular cartilage and the subchondral region of certain long bones of the extremities. This process, by sequestration from the articular cartilage, produces a loose body which is osseocartilaginous in nature and whose structure undergoes curious alteration within the joint cavity.

A myriad of names have been employed to indicate the several characteristics of this disorder and among them are found such descriptions as "Paget's quiet necrosis of joints," "subchondral fracture of the articular condyle," "osteochondrolysis traumatica," "malacopathia of the joint," "partial necrosis of the epiphysis" and "arthrolithiasis of unknown origin."

Before reviewing the etiology and the pathogenesis it should be mentioned that the majority are most often found in the knee-joint and less commonly in the elbow-joint. In our series of ten cases, eight were cases in which the knee-joint was the site of the disease and two in which the elbow was involved.

In the knee-joint, osseocartilaginous bodies may arise from three distinct anatomical sources:

(1) From the articular surfaces of the femur, patella and the tibial head and most commonly in the femur from the lateral aspect of the medial epicondyle.

(2) As osteophytes in the process of an osteoarthritis by a breaking away of the diseased tissues.

(3) As a result of proliferative changes in the synovial membrane as represented by the entity known as synovial osteochondromatosis.

In our series, the origin of the fragments found in the knee-joint at operation was as follows:

From the lateral aspect of the medial epicondyle of the femur	6 cases
From the lateral epicondyle of the femur (medial aspect)	1 case
From the articular surface of the patella	2 cases

Etiology—From an analysis of the evidence for and against the several theories of origin of the classical loose bodies that have been described with

this condition one is led to the conclusion that an entirely satisfactory explanation has not yet been offered. Trauma, low-grade bacterial infection, congenital predisposition of the femoral epiphysis, mycotic embolus have been described as being among the factors thought to be of importance in the production of the condition. Wagoner and Cohn⁴⁵ reviewed the literature with reference to theories of etiology and offer the possibility of heredity as a factor in the production of these osseocartilaginous plaques from the femoral condyle.

(a) *Trauma*—Monro (1738), Riemar (1770) and Haller (1776) were convinced of the traumatic origin of these loose bodies from the femoral condyle. Kragelund (1887)⁷ postulated a trauma of the bone-cartilage region followed by a sequestration of the area owing to a chronic inflammatory process. He reaffirmed the observation of Paget^{3, 4} that it was impossible to detach a fragment of articular cartilage simply by a blow. Axhausen (1911)¹⁵ postulated the idea that "as a result of the impaction from the opposing articular surface the blood-vessels to the part are damaged either with or without partial fracture according to the severity of the violence. This leads to necrosis of the area supplied by the damaged vessels and as a result there forms a zone of absorption resulting in gradual separation and eventual extrusion of the dead portion of the articular surface into the joint." Hellstrom (1922)²⁴ declared that 'the joint mice in osteochondritis dissecans are the result of a subchondral impression fracture. Excessive effort due to special structural conditions of the knee-joint may lead to the production of these fractures. Hence individual predisposition and the failure of firm healing of the fracture play a part in the development.' Kappis (1920)²⁰ indicated that in the knee and elbow which are the common sites of loose bodies, tangential and rotating forces may act on the convex surface of the condyle and fissure or partially or completely detach portions of the articular end. He believes that loose bodies arising from the patella are the result of tangential forces. To explain the traumatic origin in the absence of serious injury, he assumed a predisposition as the result of disease or congenital disturbance of the articular cartilage.

With the adherents of this factor the etiology of the 'joint mice' is therefore only a question of mechanics of joints and muscles and the histological pictures are the expression of a reaction of the tissues to a trauma under certain mechanical and anatomical conditions.

(b) *Embolism*—This explanation has been founded on the postulates that first mycotic-embolic closure of an epiphyseal artery may lead rapidly to epiphyseal necrosis, secondly the bacteria deposited may be vanquished by the body so that an infection does not take place and the necrosis remains aseptic. Thirdly the joint bodies may develop *in situ*, therefore, from the aseptic epiphyseal necrosis by a process of demarcation. Although the epiphyseal arteries are not terminal arteries in the anatomical sense inasmuch as fine lateral connections may be demonstrated still the anatomical findings do not prove that the functional capacity of these fine connections is suffi-

cient to insure nutrition of the epiphyseal region following closure of the chief arterial trunk

Observations in osseous tuberculosis seem to prove that the lateral connections do not suffice and that the epiphyseal arteries are "functional end arteries," and that if they are occluded there must be an interruption of nutrition in the area they supply. The tuberculous wedge-shaped necrosis in the lower epiphysis of the femur with its apex directed towards the diaphysis may very well correspond to a single epiphyseal vessel area.

(c) *Congenital predisposition* of articular cartilage was offered by Kappis²⁰ as an explanation in cases where severe injury was absent.

(d) *Bacterial Factor* —Knaggs,³³ in his conception of the "quiet necrosis of Paget," or, as he describes it, "necrosis without suppuration," believes that the initial lesion is a periostitis due, no doubt, to a microorganic infection of a very mild kind, probably staphylococcal in type. The infection invades the surface of the bone, but, owing to its feeble virulence, is speedily limited and fails to penetrate the deep surface of the compact bone.

Granulation tissue developing under the periosteum and in the Haversian canals of the superficial layers causes compression of the vessels and interferes with the blood supply of the compact bone in its deeper parts. By itself, this would not be sufficient to cause death, if the blood supply to the interior of the bone were adequate. If, however, the nutrient canal is similarly invaded, compression of the artery will seriously curtail the supply of blood to the medulla and render the circulation within the bone unequal to the demands upon it. Thus the compact bone, being gradually deprived of its blood supply, or receiving an inadequate supply, slowly passes into a state of necrosis.

In summarizing the etiology of the condition, it may be stated that the lesion does not seem to be a complete intra-articular fracture. If this were the sole reason for its being, then fragments detached from surfaces other than the lateral surface of the mesial epicondyle of the femur, the patellar surface and humeral capitellum should as regularly persist as loose bodies in the joint, which is not the case. Incomplete or subchondral fracture passing between bone and cartilage has probably the greatest number of adherents.

Were this the entire story, the partial fixation of the fragment would favor union with the bed from which it was dislodged and this is not found to be so when the joint is opened.

It is possible that the cause of the non-union is systemic and is not understood as with the certain percentage of ununited fractures of the tibial shaft.

As for the absence of a history of trauma in these cases, a fact frequently noted, it is to be remembered that the articular cartilage is devoid of nerve supply and there is extremely little sensation in the cancellous bone which it overlies. For this reason, it is possible that a fracture of the articular surface might result from undue violence and be accompanied by little or no pain. Such injuries would easily be overlooked or forgotten, and

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this would account for the frequent absence of a history of trauma of such violence as would ordinarily be considered necessary to produce such changes. In conclusion, the most logical explanation seems to be that which allows for a preliminary trauma to a non-sensitive articular surface with subsequent injury to a functional end-artery. Following the vessel damage and thrombosis, a localized area of necrosis results with sequestration of a fragment from the articular surface.

Pathology—Stages of the Process—Upon entering the joint, and especially in the knee-joint, a rather typical picture presents itself. As has been observed in this joint, the commonest site is the lateral aspect of the medial epicondyle of the femur. There are three distinct phases, stages or types of pathological picture which correspond to the extent of the process and to the degree of sequestration of the fragment.

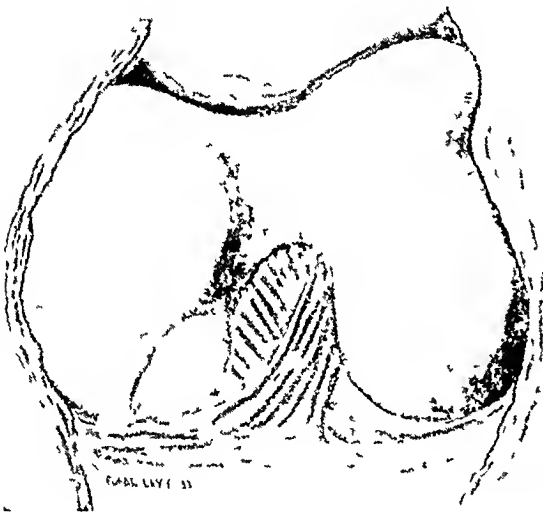


PLATE I

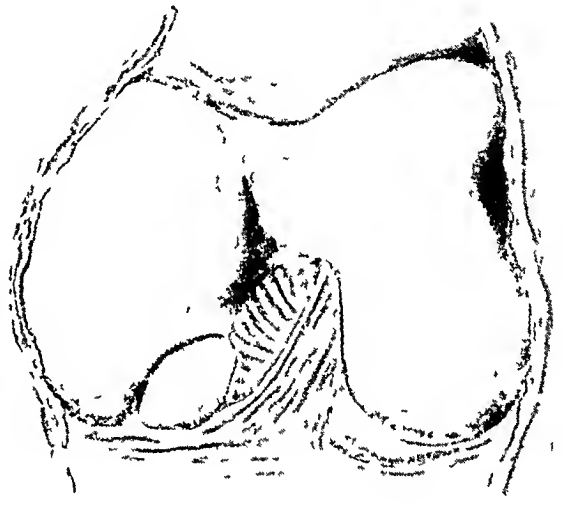


PLATE II

PLATE I—Illustrating the type of case which shows a fairly well demarcated prominence of the articular surface, with the articular cartilage covering this elevation of a different color than the rest of the cartilaginous surface.

PLATE II—Illustrating the type of case in which the fragment has become more distinctly separated and lies within the excavated area, being held there by a small adhesion.

In the first stage, there may be only a fairly well demarcated prominence of the articular surface with the articular cartilage covering this elevation of a different color than that of the rest of the cartilaginous surface (Plate I). If this prominence be excised during this period of the disease, and, as a rule, it is rather easily separated, a beginning excavation of the cancellous subchondral portion of the articular end of the bone may be observed. The ease with which this articular osseocartilaginous prominence may be removed is in striking contrast to the difficulty with which normal articular cartilage is removed from the end of any normal femoral articular surface.

The second stage in the process we recognize is one in which the fragment has become more distinctly separated and lies within the excavated area of the articular surface, being held, perhaps, by the merest shred or by a fairly firm adhesion (Plate II).

This fragment is easily removable, in fact, it may be merely lifted out of its bed. Surrounding this excavation, which resembles in character the bite of a rodent, the articular cartilage is of a peculiar appearance, having an ivory-like cast and in contrast with the normal articular cartilage, appears actually buff-colored. In addition to this color change, the cartilage is not firmly attached to the articular end of the underlying cancellous bone, but is easily removable for a varying distance from the sequestered focus. The ease with which it may be lifted gives it the actual appearance of having



FIG 1



FIG 2

FIG 1—(Case VI) Radiograph illustrating the indentation of loose body within knee joint. Injury to joint twenty five years prior to admission to hospital. Patient was informed at time of accident that loose body was present but refused operation at that time. Case regarded as being of Type III, with complete sequestration of the fragment from articular surface into joint cavity.

FIG 2—(Case VI) Anteroposterior view of radiograph shown in Fig 1, demonstrating the position of the loose body within the quadriceps bursa.

been dissected off and this characteristic is expressed in the name "osteochondritis dissecans," which was first applied to this condition by König,⁶ in 1887.

The third stage is merely the completion of the first two periods and is characterized by the complete sequestration of the fragment from its place on the articular surface into the joint cavity. The fragment may remain

freely movable within the joint cavity, being bathed by the synovial fluid and become lamellated in structure by a process of accretion (Figs 1 and 2, Case VI), or it may become affixed to the synovial wall of the joint. The excavated cavity presents of itself no distinctive features, being lined by a thin velvety layer of reddish-gray tissue. Curettings of these foci do not reveal any specific pathological picture which would indicate anything of a specific nature of the process. Cultures of the curettings removed at operation have all shown no bacterial growth.

The excavation gradually becomes filled in with fibrocartilage and in outline becomes shallower and less pronounced.

The Fragment—Following the loosening of the fragment from the articular surface, degenerative and regenerative changes occur in it, both while it is attached by a pedicle and after it has been completely extruded within the joint.

While it is attached by a pedicle, it may be nourished through blood-vessels existent within the stalk of the pedicle and the degenerative changes in the fragment be slight. However, both the articular bone and cartilage tend to a general necrosis. In some cases the proliferative changes may be considerable during this period and in the microscopical sections evidences of osteoblastic formation may be seen. Principally, the proliferative changes consist in the formation of fibrocartilage along the surface of separation—but in the area where bone is present, there may be considerable new bone production. This proliferative process is most marked in the cancellous spaces along the zone of separation, and the old bone which becomes necrotic may be replaced by new bone.

After complete liberation within the joint, all bone which has had a blood vascular circulation becomes necrotic and there is still further necrosis and calcification in the articular cartilage. The fibrocartilage and the fibrous tissue along the surface of separation receive sufficient nutrition from the synovial fluid and proliferate, thus causing a slow but steady increase in the size of the loose body. The fibrocartilage gradually absorbs and replaces the necrotic articular cartilage and less rapidly the necrotic bone, so that years after separation, the original constituents of the loose bony fragment may have completely disappeared. In many specimens removed from the joint, years after complete separation, a definite lamellation may be seen to have occurred and in one of our cases (P. M.), an arthrolith (Figs 3 and 4) presents just such an appearance. A sagittal section through this body indicates the laying down of the lamellæ around the original fragment. Concomitant with this laying down of fibrocartilage about the original particle, calcification occurs within the layers of the fibrocartilage and an extremely pathological type of new bone may be formed in its superficial portion (P. M., Case VI).

The Synovial Membrane—With regard to the synovial membrane lining the joint, one may state that the character of it will depend upon the amount of irritation that has been offered to it as the result of trauma from the

loose fragment or fragments, the extent of the hemarthrosis existent and the length of time these two factors have been present. Changes in the synovia from a simple œdema of the synovial papillæ to a pronounced hypertrophy of the individual and multiple single papillæ which have been in direct contact with the offending loose fragment have been observed (Case

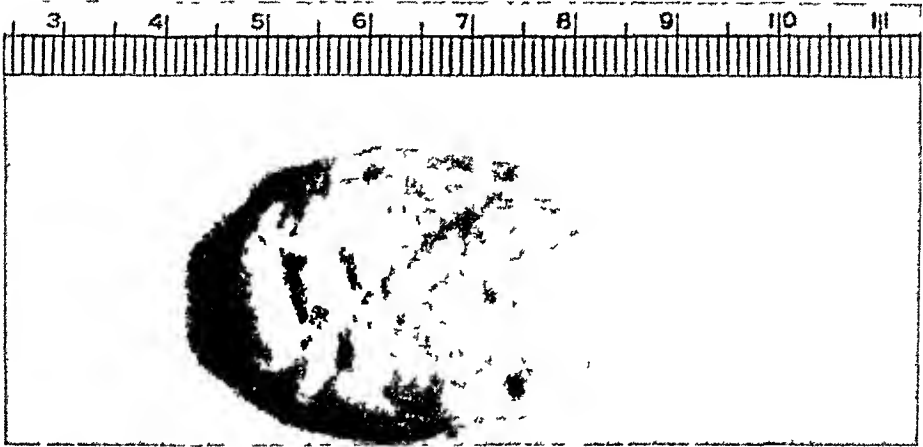


FIG 3—(Case VI) Arthrolith removed from knee joint illustrating a complete change in the character of the sequestered fragment

I, T D, Case IV, A S) The extent of this traumatic hypertrophic synovitis and its striking subsidence within a short interval following arthrotomy with the removal of the loose fragments is quite pronounced. With persistent trauma from the loose particles, joint changes of an osteoarthritic nature will result within the joint

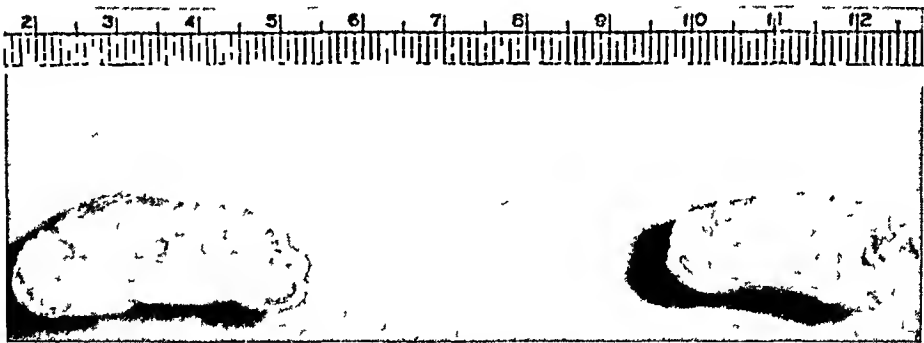


FIG 4—(Case VI) Sagittal section of the arthrolith shown in Fig 3 indicating the lamellated character of the fragment as the result of the action of synovial deposition upon the original loose body

The plates marked I, II, and III and the schema (Plate IV) accompanying them indicate the types of cases presented in this review and show rather clearly the variations one encounters on opening the joint

Chemical analyses were made of the synovial fluid in several of the cases but were not found to be of any especial import and for that reason the values obtained are not reproduced in this report

As to the pathological grouping of loose bodies that appear in joints, the following outline of Timbrell-Fisher's²² has seemed to the author to be the

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most inclusive It is inserted at this point with an idea of demonstrating the place given to the group included under the name of "osteochondritis dissecans" in its relation to other loose joint bodies

Loose Bodies of Cartilage and Bone May Be Divided into Three Groups

Group I—*Loose Bodies Occurring in Connection with Some More or Less General Pathological Condition Affecting the Joint as* (a) Osteoarthritis (1) Detached osteophytes (2) Detached epi-articular ecchondroses as a result of lipping of patella (b) *Tabes dorsalis* (c) Tuberculosis of joint accompanied by necrotic caries (d) Acute arthritis due to infection

Group II—*Loose Bodies Occurring in Joints that Are Otherwise Apparently Normal* (a) Bodies having the microscopical and sometimes the macroscopical appearances of detached portions of the articular surfaces (osteochondritis dissecans) (b) Bodies derived from the intra-articular fibrocartilages (c) Bodies formed from detached epiphyses not forming portions of an articulating area

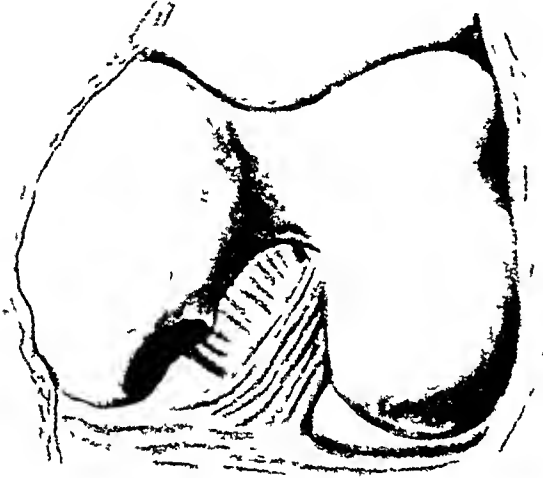


PLATE III

PLATE III—Illustrating the type of case characterized by complete sequestration of the fragment from the articular surface

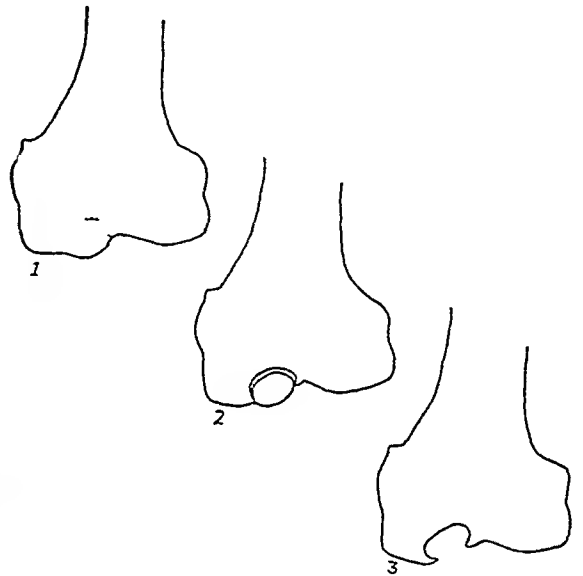


PLATE IV

PLATE IV—Schema illustrating the variations encountered

chondritis dissecans) (b) Bodies derived from the intra-articular fibrocartilages (c) Bodies formed from detached epiphyses not forming portions of an articulating area

Group III—*Synovial Chondromata, Laminated and Non-laminated* (a) Single (b) Multiple (c) Diffuse

In concluding the pathological discussion the following summary serves to coordinate the several facts elaborated above

- (1) The condition is more often seen in males than in females
- (2) The average age is from fifteen to thirty-five years, in our series, the youngest was seventeen and the oldest case fifty-two years of age with an average age of thirty
- (3) Fragments may be (a) *Recent detachments* Where bone and cartilage are living and there are no proliferative changes in the articular cartilage It is in these cases where there is no sign of any morbid process that

the clinical evidence strongly supports the traumatic origin of this group
(b) Bodies whose sojourn in the joint has been longer Where the articular cartilage shows proliferative changes *(c) Where there is marked degree of cartilage proliferation* *(d) Where cartilage proliferation is excessive* *(e) Where cartilage proliferation is feeble*

(4) Commonest site is the knee, next is the elbow

(5) The condition is usually unilateral

(6) Bodies may be completely or incompletely detached or may acquire a secondary adhesion to the synovial membrane When incompletely separated, they are usually attached by a hinge of articular cartilage to the margin of a defect or loss of substance on the articular surface which corresponds in size and shape to the loose body

(7) Their continued presence in a joint may bring about changes of an osteoarthritic nature

Symptomatology—The onset of the classical symptoms is determined usually by the extent of the pathological process and the degree of demarcation of the sequestered fragment The interval occurring between an injury and the onset of the commoner symptoms is greatly stressed by those investigators who regard the process as an aseptic necrosis However, the interval can be quite satisfactorily explained if one bears in mind the fact that the classical symptoms are due to the loose body being caught between the articular surfaces, thus giving rise to sudden attacks of pain or even locking If a loose body has become attached to the synovial membrane in such a position that it is unable to wander freely about the joint or get between the articular surfaces, or if it has not completely been detached and occupies the excavation in the articular surface, then the symptoms may not arise, with its disengagement, however, they will manifest themselves

In the group of cases which we have called the first type (Fig 5), where the radiograph reveals merely a line of demarcation of the femoral condyle (Case I, T D), there is usually a history of indefinite symptoms of weakness and disability for a long period (two months to two years) The knee is described as not being as strong or as reliable as the other Often there is a history of the affected part not being able to stand up under strain as well as the opposite member With these indefinite early symptoms which are characterized by the general feeling of disability not quite amounting to pain, is the absence of locking or "catching" of the knee-joint It may readily be appreciated why the onset of symptoms of osteochondritis dissecans is so insidious as compared to the rapidity of the symptomatology in a dislocated cartilage With the dislocated cartilage, there is, at the onset, an interposition of the curled meniscus between the articular surfaces of the femur and the tibial head and hence locking and fixation of the knee occur immediately With the further sequestration of the fragment, but without complete loosening, the symptoms of locking and synovial membrane involvement occur With osteochondritis dissecans, these disabling features do not occur at the onset but are a rather late occurrence and are preceded

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by a long history of indefinite knee-joint dysfunction. This train of symptoms we have described as belonging to the second stage of the process. It is only a matter of time when the fragment now will become completely detached and wander about the joint and in addition to the symptom of locking, the presence of a loose body becomes manifest to the patient himself (Figs 6, 7, and 8).

In the third stage, with the completely sequestered fragment within the knee-joint, the symptoms elicited in addition to an occasional attack of locking (and which in this stage is not as prominent a symptom) are those refer-



FIG 5

FIG 6

FIG 5—(Case I) Radiograph reveals a line of demarcation in the internal aspect of the external condyle of the femur. The arrows indicate the area of sequestration. This case is regarded as being Type I in character. In addition, the lateral view shown in Fig 6 reveals the presence of two calcific bodies in the quadriceps bursa.

FIG 6—(Case I) Lateral view of radiograph shown in Fig 5 showing the presence of the calcific bodies in the quadriceps bursa.

able mainly to the synovium. For this reason swelling of the knee is the most persistent and annoying feature. This is due to first, a hypertrophy of the synovial membrane itself in the form of a traumatic hypertrophic synovitis and secondly, to an increase in the synovial fluid contained therein, and is an expression of synovial reaction to repeated traumata from the loose fragment. During this period lamellation of the fragment occurs by deposition.

In our series of cases, the symptoms in order of their frequency were pain, disability, swelling and the presence of movable body. Objectively, the knee may or may not present any especial gross abnormality, for the appearance will vary with the duration of the disease, the extent of the synovial involvement and the degree of hemarthrosis present. In the majority of our cases, the knee was slightly swollen with a visible fullness in the quadriceps bursa. Flexion and extension were limited as would be expected, although in many instances, the amount of motion would vary, due, no



FIG 7



FIG 8

FIG 7—(Case IV) Radiograph illustrating type regarded as Type II, where the sequestrating fragments are merely held to the excavated area in the articular surface of femur by a small adhesion

FIG 8—(Case IV) Lateral view of radiograph shown in Fig 7

doubt, to a shifting of the loose fragments within the joint cavity. Loose bodies were felt in two of our cases prior to arthrotomy (Case VI, P M, Case I, T D) and the findings verified by the roentgenograms.

Radiographical Evidence—The radiographical picture is diagnostic and presents a characteristic appearance. In the knee-joint, the variations will depend again upon the degree of separation of the fragments. In the early stages, before complete demarcation has occurred, a rarefaction of the articular surface of the femur is present with a linear outline of the excavated

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area presenting (T D, Fig 5) Most commonly in the femur this is seen in the region of the lateral aspect of the medial epicondyle, although in the figure shown it is the internal aspect of the lateral epicondyle. With progression of the process, this linear rarefaction develops into a definite demarcation and finally into a completely excavated crater with a loose body freely movable within the knee-joint. With our cases, stereoscopical plates of the affected joints were made and proved invaluable in the detection of the condition where the cases came under observation in the early stages. In the later stages, although recognition was readily made with the plain A-P and lateral views, we found that the pre-operative stereoscopical plates afforded additional information in giving an idea as to the extent of involvement of the femoral articular surface. In the cases where the condition was of long standing and where the loose fragment had become lamellated as the result of synovial deposition on the sequestered fragment, the radiograph indicated this concentric deposit and Fig 1 (P M) is a rather striking illustration of this effect.

Treatment—The treatment of osteochondritis dissecans is arthrotomy with the removal of the sequestered fragments. In cases where the fragment lies in the excavation and is not completely detached we have removed the piece and curetted the excavation. In cases where the cartilage is loosened about the edges of the crater-like depression in the articular surface of the femur, we have removed it for varying distances about this edge, the amount depending entirely upon the degree of undermining which has occurred.

The optimum time for intervention is during the stage of demarcation, before complete sequestration has occurred as the degree of synovitis is at a minimum at that time. It will be readily appreciated that with the advancement of a marked synovitis, the residual dysfunction will be increased and the convalescence prolonged.

With reference to the technic employed, a word should be said to what we believe to be the most important single step in the procedure and that is the pre-operative skin preparation. It has been our custom to subject these cases to a forty-eight-hour pre-operative skin preparation usually supervised and sometimes performed by the operator himself. The incision employed has been the rather standardized longitudinal parapatellar incision which can be extended to suit the needs of the operator and which will allow easy lateral or medial retraction of the patella. In our experience this approach has been the simplest and has given the most satisfactory exposure with the least amount of damage to the peri-articular structures.

The convalescence of these cases was entirely uneventful and motion was started by the patient himself on the twelfth to the fourteenth day after operation. For a period of four to five weeks after being discharged from the hospital they all returned to the surgical clinic where physiotherapeutic stimulation in the form of baking to the knee and massage of the quadriceps

TABLE I
Analysis of Cases

Case Admitted and Discharged	Days in Hospital	Age	Sex	Joint	Disability	Predominating Symptoms	Duration	Previous Trauma	Operation	Location of Fragments	Function	Result
Case I—T D 9-30-31 10-16-31	16	25	M	Left knee	E—135° F— 90°	Pain limitation of motion, palpable loose bodies	5 yrs	+	Arthrotomy with removal of loose bodies	External condyle of femur	At 6 mos, E—180°, F—100°	Satisfactory
Case II—C J 11-25-31 12-15-31	20	23	M	Left knee	E—135° F— 90°	Pain swelling	2 yrs	o	Arthrotomy with removal of loose bodies	(1) Internal condyle of femur, (2) patella	At 6 mos, complete restoration	Excellent
Case III—J N 10-29-31 11-17-31	19	39	M	Left knee	E— 0° F— 0°	Disability, swelling	3 mos	o	Arthrotomy with removal of loose bodies	Internal condyle of femur	At 18 mos, complete restoration	Excellent
Case IV—A S 12-13-31 12-30-31	17	20	M	Right knee	E— 0° F— 0°	Swelling, pain	8 mos	+	Arthrotomy with removal of loose bodies	Internal condyle of femur	At 18 mos complete restoration	Excellent
Case V—G M 3-22-32 4- 6-32	15	32	M	Left knee	E—145° F— 95°	Pain, swelling	2 mos	+	Arthrotomy with removal of loose bodies	Internal condyle of femur	At 6 mos, complete restoration	Excellent
Case VI—P M 5-23-32 6-16-32	24	52	M	Right knee	E—120° F— 90°	Palpable loose body, swelling	25 yrs	+	Arthrotomy with removal of loose bodies	Internal condyle of femur	At 5 mos, complete restoration	Excellent
Case VII—L T 10-28-32 12- 8-32	41	17	M	Right knee	E— 0° F— 0°	Pain	1 day	+	Arthrotomy with removal of loose bodies	Patella	At 3 mos, E—180°, F—100°	Improved
Case VIII—M S O P D	—	45	M	Right elbow	—	Swelling	4 mos	+	Non operative	Capitulum of humerus		With physiotherapy symptomatically improved
Case IX—M S O P D	—	28	M	Right knee	E—135° F— 90°	Pain, swelling	3 mos	+	Non operative	Internal condyle of femur		With physiotherapy symptomatically improved
Case X—B J O P D	—	30	M	Right elbow	—	Pain, disability	6 mos	+	Non operative	Capitulum of humerus		With physiotherapy symptomatically improved

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femoris were employed. The average period of disability in these cases was from eight to ten weeks.

The follow-up in these cases was rather satisfactory. Six of the seven operated cases reported regularly once a month for a period of six months and three continued for more than a year. The three non-operated cases continue under our observation at the present time. They are all receiving symptomatic relief from baking treatments to the affected part—undoubtedly owing to a defervescence of the synovitis existing within the joint.

CONCLUSIONS

(1) The condition of osteochondritis dissecans is more frequent than is assumed, ten cases having been isolated over a two-year period.

(2) Three types, stages or groups of the process are postulated and the varying symptomatology will depend upon the type, the degree of sequestration of the fragment, and the amount of synovial irritation that has occurred.

(3) There is nothing specific in the pathological picture, all degrees of bone and cartilage transformation being observed in the loose bodies removed at operation. Deposition upon loose bodies is demonstrated by the section of a fragment which had been within a knee-joint for twenty-five years.

(4) The radiograph is usually pathognomonic and stereoscopical views of the affected joints are invaluable in the determination of the amount and degree of articular damage.

(5) The treatment is arthrotomy with the removal of the loose fragments and the optimum time for surgical intervention is during the period of demarcation before any great degree of synovial change has occurred.

(6) The cases followed for more than one year showed no regression or return of the condition either symptomatically or radiographically.

CASE REPORTS

CASE I—(T. D.) Colored male, aged twenty-five, chauffeur by occupation, was admitted to the Surgical Service of Dr. John F. Connors, September 30, 1931, with the complaint of acute pain and swelling of the left knee of five weeks' duration. He states that five years ago (1926) he dropped a piece of steel on the left knee and that shortly thereafter his knee became swollen. At that time he was informed that he had "rheumatism" and hot fomentations were advised. The external applications of heat reduced the swelling somewhat but did not completely remove the "soreness." Five weeks ago he twisted his knee and since that time the knee has remained swollen. Walking is impossible without the aid of crutches. There is no other joint involvement.

Past History—Negative except for influenza in 1918. G. C. and lues denied.

Physical examination, negative except for the left knee-joint which is swollen. Extension to 135° and flexion of knee to only 90°. Palpation of the quadriceps bursa gives sensation of palpable intra-articular bodies.

Radiograph—(No. 10519) Left knee. In the anteroposterior view there is an area of demarcation of region of the external condyle of the femur at its internal aspect. Fragment appears to be sequestering from the articular surface. In the lateral view two calcific bodies may be seen in the region of the quadriceps pouch. Stereoscopical views of joint.

Diagnosis—Osteochondritis dissecans, left knee-joint.

The knee-joint was prepared in the customary manner for forty-eight hours prior to operation

Operation—(October 2, 1931) A five-inch parapatellar incision was made lateral to the patella and extending from the region of the suprapatella bursa down to the head of the tibia The joint was opened and in the quadriceps pouch a calcific body was found about the size of a small walnut Lateral and below, a similar calcific body was seen attached by a small cartilaginous pedicle to the synovial lining of the knee-joint proper The entire synovia was red and injected and in one or two places seemed to give evidence of a definite villous synovitis On flexing the knee a clicking noise was elicited and it was seen that there was a definite obstacle to complete knee-joint function It was thought that another incision was more advisable and for that reason a similar incision was made on the medial side of the patella On the inferior surface of the lateral epicondyle a small osseocartilaginous plaque about the size of a twenty-five-cent



FIG 9—(Case I) (T D) Fragments removed from the knee joint (1) Plaque from the articular surface of the femoral condyle (external) (2) Loose body removed from the quadriceps pouch (3) Loose body present in the quadriceps pouch, showing pedicle attachment (4) Hyper trophied villus present in the joint

piece was seen rather firmly adherent to the condyle of the femur This was removed, and, following its removal, motion at the knee became quite free and unrestricted The cartilage of the femoral condyle in the region of this excavation was fragile and was removed for an area of about three-quarters of an inch surrounding the eroded portion It was buff-colored in appearance and was of an entirely different character than the cartilage covering the rest of the articular surface The joint cavity was irrigated with normal saline and the capsule closed in layers with No 0 chromic catgut and bleeding points were secured and a continuous silk stitch was used for the closure of each incision A firm molded plaster-of-Paris splint was applied with the knee in slight flexion

Pathological Report—Gross specimens are shown in Fig 9 *Microscopically* reported as necrotic subchondral bone undergoing decalcification and absorption

Post-operative Course—Uneventful, the wound of the knee healed by primary

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union Follow-up at six months the flexion of the knee was 100° and the extension 180°

CASE II—(C J) Colored male aged twenty-three years was admitted to the Surgical Service of the Harlem Hospital November 25 1931 with the history of pain and swelling of the left knee of two years' duration Onset in November, 1929 when he first noticed slight stiffness in the left knee and noticed that both flexion and extension were slightly limited At that time he paid little attention to the condition thinking it would soon pass away He does not recall having injured the knee at any time Three weeks before coming to the hospital the knee-joint became quite painful and swelling was more pronounced

Past History.—Negative and family history is irrelevant No other member of his family has ever had any similar affliction

He was a well-developed man whose physical condition was entirely negative except for the local surgical condition in the left knee. Left knee-joint was larger in circumference than the right knee Flexion present to 90° and extension to 135° There was fluid within the knee-joint as evidenced by the eliciting of the patella click and the prominence of the quadriceps bursa



FIG 10—(C J) Fragments removed from knee-joint (1 and 2) Plaque from the articular surface of femoral condyle. (3) Curettings from the excavated area of the femoral condyle (4 and 5) Articular cartilage surrounding the excavated area on the femoral condyle.

Radiograph.—Examination of the left knee-joint showed destruction of the lateral portion of the articular surface of the internal condyle of the femur The erosion appeared adjacent to the intercondyloid notch of the femur In addition there were loose bodies within the knee-joint and synovial thickening was present

Diagnosis.—Loose bodies within joint due to osteochondritis dissecans involving the femoral condyle.

Operation.—(November 27 1931) A medial parapatellar incision seven inches in length was made When the joint capsule was opened a moderate amount of fluid exuded On the posterior surface of the internal condyle of the femur an area about the size of a twenty-five-cent piece was seen completely denuded of cartilage At the same time the loose fragment of cartilage which had separated from that area was seen lying free in the joint and was removed The entire synovial membrane appeared red and injected The denuded area on the inferior surface of the condyle of the femur was curetted and the cartilage excised for about one-third of an inch about this area All bleeding points were secured and the joint flushed with sterile saline The joint capsule was closed Gross specimens shown in Fig 10

Post-operative Course.—Satisfactory and entirely uneventful Complete extension is present in spite of some quadriceps atrophy

Follow-up Note.—(February 1 1932) Stated that the patient is walking without pain or discomfort and motion is practically normal except for some slight limitation in flexion which at this time is about 110°

CASE III—(J N) A well-developed and well-nourished colored male of thirty-

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nine was admitted to the Surgical Service of the Harlem Hospital October 29, 1931, with the complaint of weakness in the left knee-joint of three months' duration. For this period immediately preceding admission he states that his left knee has been slightly swollen and does not stand up under any strain as well as his right knee. There has been no locking of the knee-joint but flexion and extension have been limited to a slight degree sufficient to cause him to limp when walking.

Past History—Negative except for pneumonia.

Physical examination negative except for the left knee-joint which is swollen. There is complete limitation of flexion and extension.

Laboratory Data—Negative.

Radiograph shows an irregularity of the articular cartilage of the right internal femoral condyle on its internal aspect in the region of the intercondyloid notch. There is also present a circular calcific body about 1 centimetre in diameter. Fluid is present within the joint and a synovitis exists.

November 1, 1931, the knee-joint was opened by a seven-inch medial parapatellar incision. When the capsule was incised about 200 cubic centimetres of straw-colored fluid were evacuated from cavity of the joint. An osseocartilaginous mass was with-

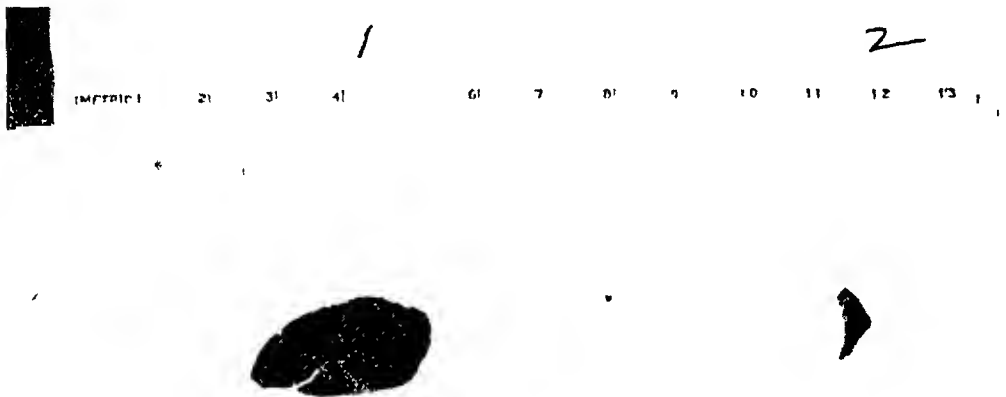


FIG 11—(J N) Fragments removed from knee joint. (1 and 2) Fragments removed from the articular surface of the femoral condyle.

drawn. The mass was about three-quarters of an inch to one inch long and one-half inch wide. This was found to have sequestered from the external aspect of the medial condyle in the region of the intercondyloid notch where an excavation was present. The area was curetted and a red-gray granulation tissue removed and sent to the laboratory for culture and microscopical examination. Another similar mass of similar characteristics was withdrawn. The joint was closed tightly with interrupted mattress sutures. Patella was replaced and the skin wound sutured with interrupted silk.

Pathological Report—Gross specimens shown in Fig 11. Specimen consists of six irregular-shaped fragments, two of which are about one inch in length and the others about one-quarter inch in diameter. The specimens are nodular, firm and some of them exhibit processes which appear to be dendritic in shape. Consistency is markedly firm and on cut section shows hæmorrhagic areas surrounded by white fibrous tissue. Examination discloses loose connective tissue which in some areas is quite vascular. In other areas it gives the appearance of a keloid. There is no evidence of tuberculosis or other specific inflammatory condition. The post-operative course was uneventful and entirely satisfactory. Thirteen months after operation X-rays demonstrate no abnormalities. Patient is symptom-free.

CASE IV—(A S) Colored male, aged twenty, was admitted to the Surgical Service of the Harlem Hospital December 13, 1931, on account of pain, swelling and

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inability to flex or extend right knee of one week's duration Eight months ago he fell from a height while working and landed on the heel of his right foot At this time he states that "something caught" in his knee-joint which loosened up after a few minutes This sensation had occurred about every two weeks since One week ago his knee became quite swollen

Physical examination negative except for the local condition in the right knee which is markedly enlarged and distended by fluid Flexion or extension causes marked distress and for that reason the extremity is held rigidly extended December 15, 1931, the right knee-joint was aspirated and fifty cubic centimetres of bloody fluid obtained A median parapatellar incision was made extending about three inches above and below the mid-point of the patella The joint capsule was seen to be bluish in color, indicating the presence of more sanguinous fluid within the joint On opening the knee-joint about six ounces of bloody joint fluid gushed forth When the articular surface of the femur was brought into view the medial condyle presented a characteristic excavation with

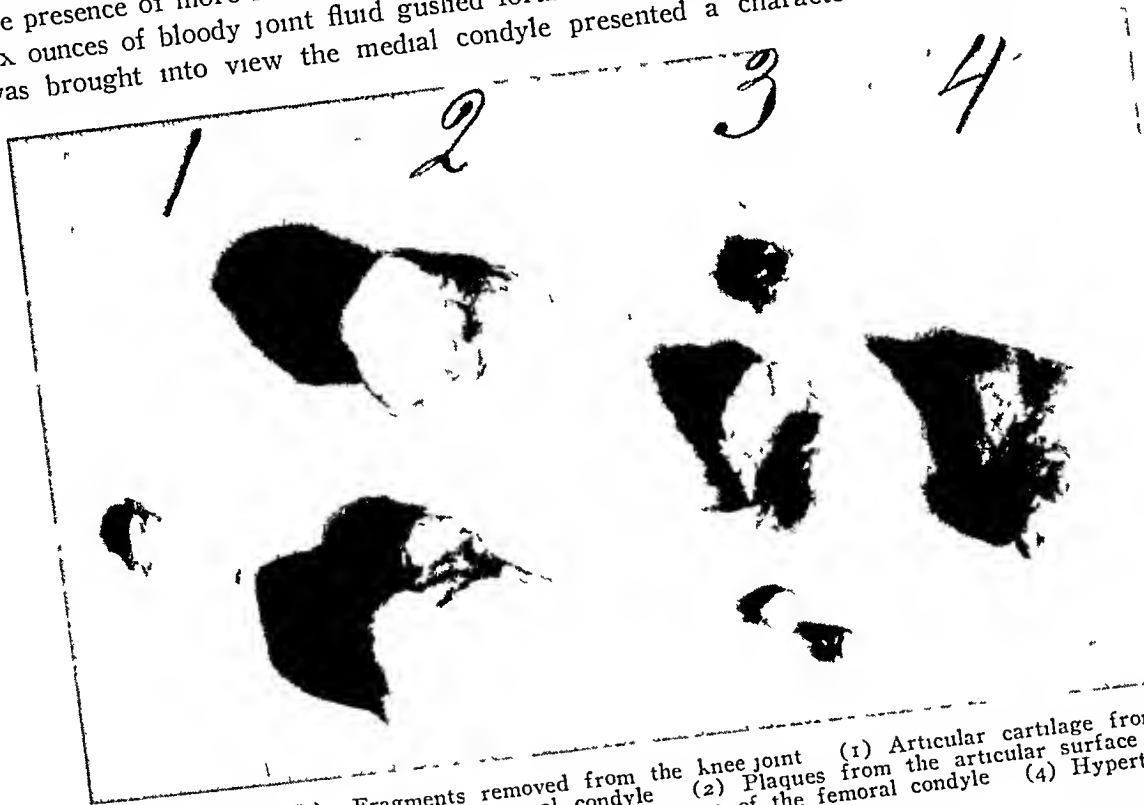


FIG 12—(A S) Fragments removed from the knee joint (1) Articular cartilage from area surrounding the excavation on the femoral condyle (2) Plaques from the articular surface of the femoral condyle (3) Curettings from the excavated area of the femoral condyle (4) Hypertrophied villus removed from the joint

the two fragments (Figs 12 and 13) which had previously been seen in the X-ray picture lying in this crater The depression was lined with a reddish-gray granulation tissue The fragments, which were held by the thinnest pedicle, were removed The entire synovial membrane presented the appearance of a chronic hypertrophic synovitis and was stained yellow from the sanguineous joint fluid No other fragments were found in the knee-joint but one hypertrophied villus was removed for microscopical examination Following the removal of the fragments mentioned above the excavated area was curetted All bleeding points were secured and the joint capsule closed The post-operative course was uneventful and entirely satisfactory

One year later he was symptom-free and has normal range of knee movements which are unrestricted X-rays show no loose bodies in knee-joint

CASE V—(G M) A colored male of thirty-one years was admitted to the Surgical Service of the Harlem Hospital March 22, 1932, with the complaint of pain and weakness in the left knee-joint of two months' duration He states that eighteen months ago he fell and struck his left knee but noticed no untoward effect other than some slight intermittent pain which would occur at irregular intervals This pain in the left

knee has become more persistent during the past two months preceding admission and for the past two weeks has been especially troublesome. He has never had any locking of the knee-joint but flexion and extension are now painful and are relieved only by keeping the extremity at rest and fully extended.

Radiograph of the left knee shows a protuberance in the region of the medial epicondyle of the femur near the intercondylar notch which is suggestive of an osteochondritis dissecans.

March 24, 1932, the knee was opened by a six-inch medial parapatellar incision. Prior to the opening of the capsule, the knee-joint was aspirated and about 100 cubic centimetres of dark yellow joint fluid obtained. On opening the knee-joint the entire synovia was seen to be reddened and the villi were hypertrophied. On the internal aspect of the medial condyle a typical loose body characteristic of the disease was found. It had not quite separated from the articular cartilage and for that reason was removed with sharp dissection. The cartilage surrounding the excavation was examined and



FIG 13—(A S) Fragments removed from the knee joint. Shows reverse side of fragments removed from the femoral condyle.

found to be slightly undermined. In addition, one of the inflamed hypertrophied villi was also removed. The joint was then closed. The post-operative course was entirely satisfactory and uneventful.

Examination six months later shows the patient to be without symptoms, with motion in the knee unrestricted. The incisional scar is painless and he is able to walk about and perform his regular duties.

CASE VI—White male of fifty-two years was admitted to the Surgical Service of the Harlem Hospital May 23, 1932, with the history of having been thrown from a horse twenty-five years before (1907), and having suffered an injury to his right knee. The condition in the knee improved with local treatments but he was never without slight pain and disability. He was told at that time that he had a "loose piece" of bone in his knee-joint but refused operation. For the past eight months preceding his admission his knee has been swollen and motion has been limited. At the present time he is able to palpate a loose body within the knee-joint and move it from side to side in the quadriceps bursa.

The right knee is markedly enlarged. A movable bony mass may be felt within the quadriceps bursa. Extension present to 120° and flexion to 90°.

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Radiograph shows a loose calcific lamellated body about three and a half centimetres in length present in the quadriceps bursa. In addition, a small niche is present on the medial condyle of the femur just medial to the intercondyloid notch.

May 27, 1932, the knee-joint was opened by a median parapatellar incision about seven inches in length. The loose body which had been seen on X-ray examination was found in the quadriceps bursa and was removed. It measured two inches by one and a half inches by three-quarters of an inch in thickness. The entire synovial membrane of the knee-joint was dark brown and sanguineous in color and seemed to be the site of a traumatic hypertrophic villous synovitis. Examination of the condyles of the femur revealed an eroded area on the inner aspect of the medial condyle. The cartilage of this area was eroded, of a different color, being more yellow, and less firm in consistency. Undoubtedly, this was the site from which the original loose body had been extruded at the time of the trauma twenty-five years ago.

The post-operative course was entirely uneventful.

Five months later the patient is symptom-free and is walking about with range of motion as follows: Extension 180° and flexion 100° . There is no pain in the incisional scar.

CASE VII.—A colored male of seventeen years was admitted to the Surgical Service of the Harlem Hospital October 28, 1932, with the history of pain, swelling and inability to move the right knee-joint of one day's duration. On the day preceding admission he was tackled while playing football and suffered injury to the right knee. The knee-joint is painful and swollen and extension and flexion are restricted.

Radiograph shows a loose body within the knee-joint, medial to the internal condyle of femur. An arthrotomy was done with removal of fragment which had become sequestered from the posterior surface of the patella. The post-operative course was uneventful.

CASE VIII.—A white male of forty-five years was admitted to the Orthopedic Clinic of the Harlem Hospital with the complaint of pain and swelling of the right elbow-joint. Onset followed a blow received four months previously.

Examination revealed a prominence over the radiohumeral bursa and limitation of flexion and extension of the forearm.

Radiograph revealed a loose body in the right joint sequestered from the capitellum of the humerus. He was advised to have an arthrotomy and removal of the loose body but refused. He was referred to the Department of Physiotherapy where he has been receiving baking of the elbow with some symptomatic relief and is being observed at the present time.

CASE IX.—A colored male of twenty-eight years was admitted to the Orthopedic Clinic of the Harlem Hospital November 10, 1932, with the complaint of pain and swelling of the right knee-joint of three months' duration. Onset of disability followed a fall on the knee and has become increasingly more pronounced.

Examination reveals swelling of the right knee-joint and limitation of flexion to 90° and extension present to only 135° .

Radiograph demonstrates an erosion and the presence of a sequestering calcific body on the medial condyle of the femur in the region of the intercondyloid notch. The patient was advised to enter the hospital for arthrotomy and removal of fragments but refused. He was referred to the Physiotherapy Department where baking was administered with slight symptomatic relief.

CASE X.—A white male of thirty years was admitted to the Orthopedic Clinic of the Harlem Hospital August 10, 1932, with a six-months' history of pain and swelling of the right elbow-joint.

Examination revealed a prominence over the radiohumeral bursa and limitation of flexion and extension of the forearm.

Radiograph revealed a loose body in the right elbow-joint sequestered from the capitellum of the humerus. He was advised to have an arthrotomy and removal of

the loose body but refused. He was referred to the Department of Physiotherapy where he has been receiving baking of the elbow with some symptomatic relief and is being observed at the present time.

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SOLITARY BONE CYST^{*}

THE LOCALIZED FORM OF OSTEITIS FIBROSA CYSTICA

BY BRADLEY L. COLEY, M.D., AND NORMAN L. HIGINBOTHAM, M.D.
OF NEW YORK, N. Y.

AMONG the less common diseases of the skeletal system, bone cyst, *i.e.*, the localized form of osteitis fibrosa, is of particular interest and importance. Since the more general use of radiographic examination for patients complaining of symptoms in the extremities, this condition is now being recognized much more frequently. Its differentiation, however, from other pathological conditions of bone is important, since a correct diagnosis is essential in order that treatment be carried out to the best advantage and an accurate prognosis given.

It is the purpose of this paper to discuss the etiology, the diagnosis, the treatment and the prognosis, based upon a study of the literature, and, in particular, upon a series of twenty-six cases personally observed at the Hospital for Ruptured and Crippled, Memorial Hospital and Lincoln Hospital.

Historical—Bone cyst was first recognized by Virchow in 1876, who described a case found at autopsy in the humerus of a patient fifty-four years old. As early as 1879, Sonnenberg recorded a case of traumatic origin in an adolescent, and Schlange, in 1887, described a similar case. The specimens of both of these cases were examined by von Recklinghausen, who in 1891 described in detail the fibrocystic degeneration in the long bones to which the term "von Recklinghausen's disease" has been given.

Henneke was apparently the first one to study this condition by means of the Röntgen-ray (1903).

Pfeifer, in 1907, contributed to the histological, bacteriological and radiographic study. From this time on the condition has attracted increasing attention and during the last decade a large number of contributions have appeared, among which may be mentioned those of Bloodgood, Platau, Silver, Sisk and especially Geschickter and Copeland.

Description of the Disease—Solitary bone cyst is a distinct clinical entity which has certain well-recognized characteristics. It has its onset during the period of childhood and adolescence, which is also the period of greatest activity of bone growth. It has a predilection for the metaphyseal region of certain long bones, most noteworthy of which are the upper extremities of the femur, humerus and tibia. Symptoms are usually extremely mild and it is for this reason that about half of the cases are not suspected prior to the occurrence of a pathological fracture. Moreover, in cases without fracture the duration of symptoms from onset to first admission is long, averaging well over two years and in some cases (latent bone cysts) it may be from five to ten or more years.

* Read before the New York Surgical Society, April 26, 1933.

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Physical examination alone rarely furnishes a clue to the underlying condition (unless fracture has previously occurred) and the diagnosis is seldom established until radiographs have been made. The area of localized bone destruction close to the epiphysis, but always on the diaphyseal side, with a circumscribed expanded cortex and often some trabeculation, makes a characteristic radiographic picture, which is usually easily recognized.

Intermediate Forms—There have been described cystic processes in the long bones which partake somewhat of the nature of both giant-cell tumor and bone cyst. Tavernier reports in detail three cases personally observed which he terms "a bone disease intermediary between giant-cell tumor and bone cyst." Geschickter and Copeland describe what they term giant-cell variants of bone cyst and state that their chief distinctive feature lies in

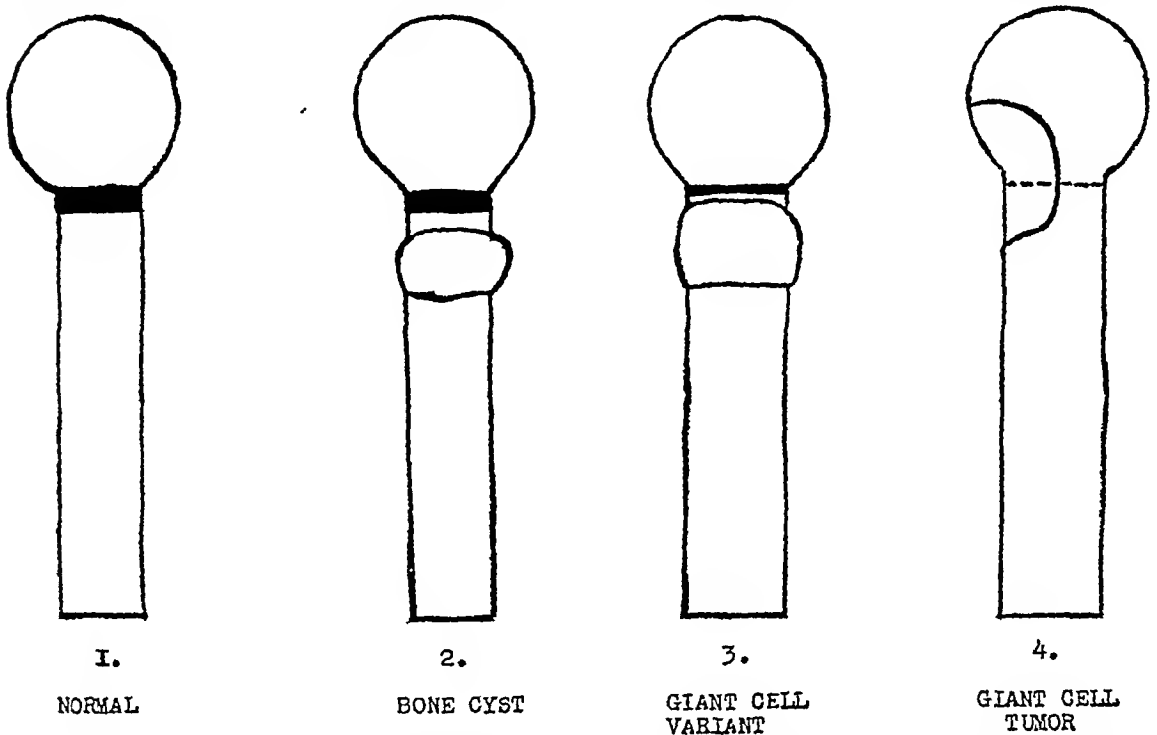


FIG 1—Schematic drawing showing location, in respect to epiphyseal line of the involved area in (2) bone cyst, (3) giant cell variant of bone cyst, and (4) giant cell tumor

Note especially the proximity of process to epiphyseal line in (3), also that epiphysis is about to unite. And in (4) that it involves the head rather than the shaft side of the epiphyseal line (now united) though extending across to involve metaphyseal area somewhat

their shorter duration of symptoms (six months or less). They also discuss a form which they have called polycystic osteitis fibrosa. However, it seems unnecessary to differentiate this group from the remainder of the solitary bone cysts except upon radiographic appearance—its clinical significance is not evident. These intermediate forms are of interest chiefly because they provide further presumptive evidence of the close association of giant-cell tumor and bone cyst.

It is our belief that the giant-cell variant of bone cyst occupies an intermediate position between simple bone cyst and giant-cell tumor (Fig 1). It occurs more nearly at the time of union of the epiphysis, whereas bone cyst begins at an earlier age and giant-cell tumor after the epiphyseal union has taken place. Its clinical course, however, runs more closely parallel to

that of the simple cyst than that of the giant-cell tumor. It is more of a regressive than a progressive osteoclastasia.

Expressed in another way, it may be said that in general the true bone cyst has its inception during childhood, the giant-cell variant during adolescence, and the giant-cell tumor after skeletal growth has been attained.

In bone cyst the entire course of the disease is indicative of the essentially benign nature of the process. It has a tendency to increase in size, but very slowly, to heal spontaneously, and to be aided in this healing process as a result of a pathological fracture. It yields to conservative surgery. It is always surrounded by a shell of cortical bone, which is never completely eroded and remains intact unless there has been a fracture. Following fracture, which may be caused by the most trivial of injuries, the rapid formation of callus and progressive healing with firm bony union is the rule. Fracture does not always result in complete healing of the cyst and at a later date a second fracture may occur.

Classification of Bone Cyst—The classification suggested by Bloodgood in 1910 has been followed by most subsequent writers on this subject. It is as follows:

- (1) Single cyst, bony shell, no connective-tissue lining
- (2) Cysts with a definite connective-tissue lining varying as a rule from one to two mm
- (3) A small cyst, or cysts, in a solid mass of osteitis fibrosa
- (4) No cyst, but bone shell filled with a solid mass of osteitis fibrosa
- (5) Multilocular cysts

This classification seems to be based mainly on the gross pathology as found at operation. The clinical significance of these separate groups is not apparent. They represent different stages in a pathological process, which probably begins with a subcortical hæmorrhage followed in turn by localized bone destruction, a zone of vascular granulation tissue, in which osteoclasts (giant cells) are found, fibrosis and, later, cyst formation. Ultimate healing is slow, a fact probably due to the difficulty with which a dead space is obliterated when its walls are rigid.

Etiology—As yet, no agreement has been reached as to the etiology of simple bone cyst. Several theories may be mentioned and each has its proponents, and against each there are weighty arguments. Some of these theories may be mentioned and briefly discussed.

(1) *Theory of Trauma* *Traumatic Hematoma*—This theory has attracted a number of writers. Jenckel, after a study of eight cases, believed bone cyst is often caused by hæmorrhage. Lang concluded that a traumatic hematoma is the first factor in the development of a solitary cyst. Bencke also attempted to prove the theory that a hæmorrhage into the bone, which for some reason is not organized or absorbed, is the cause of cyst formation. Anshütz considered trauma an important etiological factor, Mauclair and Burnier regarded it as the most frequent cause. Platau, and Mouchet and Le Gac opposed the theory of trauma, the latter on the ground that all their cases showed well-developed cysts in a very short period after the trauma.

(2) *Theory of Inflammation* *Infection* Bloodgood early adopted the view that

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osteitis fibrosa is primarily an inflammatory condition, in which the medullary portion of the bone is replaced by connective tissue Hamberlin believed that osteitis fibrosa is a circumscribed endosteal fibrogenous osteomatosis or an osteoplastic metaplasia of the endosteum with secondary fibrosis of the medulla, associated with giant-cell collections and degenerations of connective tissue secondary to these He conceived that the process might be the result of a low-grade infection

Pfeifer, reporting on a histological, bacteriological and radiographical study of four cases, concluded that the circumscribed bone cysts are nothing but softening centers of inflammatory tissue in bone marrow

(3) *Theory of Metabolic Origin Faulty Calcium Metabolism*—In their effort to determine the cause of the formation of bone cyst, some writers have been impelled by the evidence of malacia to attempt to show a relationship between bone cyst and Paget's disease in the adult, and rickets in children Yet, as Sisk has stated, despite some similarity in radiographical appearance, and a fundamental change in calcium metabolism common to all of these conditions, there is still lacking plausible evidence linking them together He was probably referring to the multiple form of osteitis fibrosa, or von Recklinghausen's disease, which is a distinct clinical entity not to be confused with solitary bone cyst We believe that metabolic disturbances play no part in the etiology of bone cyst Fujii considers osteitis fibrosa cystica as totally distinct from and independent of osteomalacia

(4) *Theory of Abnormal Hyperplasia of Osteoclasts Progressive Osteoclastasia*—This theory, advanced by Geschickter and Copeland, concludes that bone cyst and giant-cell tumor are results of an abnormal hyperplasia of osteoclasts This is preceded by a normal stage in which osteoclastic proliferation is taking place as a step in the histogenesis of bone that is developed from preformed cartilage They suggest the term progressive osteoclastasia for the process in giant-cell tumor, and regressive osteoclastasia for the process in bone cysts They support their view by showing that wherever giant-cell tumors are found they are situated where osteogenesis in cartilage is possible Their theory invokes that of trauma in that it depends upon a traumatized subcortical area in which there has been an interruption of the blood supply from the periosteum to the cortical bone with the development of a subperiosteal hematoma The medullary circulation in the region of the epiphysis must, by increased activity and establishment of new channels around the injured area, undertake the function of repair But this increased activity occurs during a period when cortical bone, cut off from its circulation, is undergoing necrosis Thus an unequal balance is struck between bone destruction (osteoclasts) and reparative new bone formation that would follow from reactive cortex if the circulation were intact

Summary of Etiology—While there is no single accepted theory to account for the development of solitary bone cyst, one can point out the fact that each of those mentioned lacks conclusive evidence to support it and is open to objections Those who believe trauma is responsible do not explain those cases which give an insidious history unassociated with a definite injury And while trauma is undoubtedly a factor of major importance in calling attention to an abnormal condition in the bone, it is usually because it produces at least a partial fracture and immediate radiographs have shown the presence of a cyst already well developed I have not been able to find a case which would tend, by the following sequence of events, to prove the etiological importance of trauma, *i.e.* history of injury, radiographs made at once showing normal bone, later persistence of symptoms calling for further radiographs which then showed the presence of a cyst It seems clear, then, that trauma is the frequent exciting factor in the recognition of a cyst, but by no means certain that it initiates it

There is little scientific basis for the assumption that a calcium deficiency is the underlying cause In five cases blood-calcium determinations were made and were within normal limits in each instance In none of these cases has any other bone later

become involved in the cystic process. No dietary deficiencies have been established as existent in cases in this group.

As for the inflammatory theory, the presence of an infectious or toxic agent has never been established. Bacteriological studies have been unsuccessful in obtaining evidence of a causative organism. Yet the histology and the clinical course point rather clearly to the supposition that a low-grade inflammatory process is responsible for the development of bone cyst. However, the picture differs in most cases from that of a Brodie's abscess which is known to be due to a low-grade central osteomyelitis. It more closely resembles a healing process in its varying stages. But what evokes the need for bone repair?

The conception of Geschickter and Copeland—abnormal hyperplasia of osteoclasts—seems at present to rest upon the most secure foundation of facts and has the added attraction that it applies equally well to the development of bone cyst and of giant-cell tumor. It is based upon the known facts of blood supply and of bone repair and bone absorption by osteoclasts. It does not explain those cases in which there has been no trauma, nor does it take into account the fact that though most children undoubtedly sustain many injuries of a minor nature to the growing ends of their long bones, still bone cyst is a relatively uncommon finding. The same may be said for the young adult in relation to giant-cell tumor. Nor does their theory account for the relative rarity of bone cyst in the lower end of the femur, a site in which giant-cell tumor appears most frequently.

Symptoms and Physical Signs—The absence of pronounced symptoms in uncomplicated cases of solitary bone cyst is one of the features of this condition.

Pain is the commonest complaint, but is often so trivial and intermittent as to arouse no suspicions on the part of the patient and it is for this reason that a long interval between the onset and first visit to the clinic is the rule rather than the exception. The pain may be present only after prolonged function or slight strain.

Pathological fracture is frequently the first symptom. It was obviously the initial symptom in ten of the seventeen cases in this series in which the history is definite. The occurrence, in a child, of a fracture of a long bone near a joint from trivial injury should arouse immediate suspicion of the presence of a bone cyst.

Swelling is not a prominent symptom and is usually not detectable unless the cyst lies in a relatively exposed position, such as the lower end of the radius, ulna or upper tibia.

Disability is mentioned in the histories of only two of the seventeen cases prior to fracture, it is obviously complained of by all the patients in whom fracture has occurred, but rapidly disappears with healing of the fracture.

Radiographic Appearance—The bone cyst has certain well-defined characteristic roentgenographic features. Among these may be mentioned the metaphyseal location, the decided thinning of the cortex with expansion, usually slight in degree, and with intact shell unless a pathological fracture has occurred. In cases that have had one or more fractures the subsequent healing frequently is associated with dense new bone formation, which may traverse the cystic area in one or more trabeculations. The examination of a

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considerable number of typical films of solitary bone cyst will enable one to recognize this condition, when it is subsequently encountered whereas it is difficult to describe it. It may simulate in appearance a giant-cell tumor but it occurs in younger individuals and almost always before the adjacent epiphysis has united. It should be especially emphasized that bone cysts commence in the metaphysis on the diaphyseal side of the epiphyseal line whereas giant-cell tumors begin in the epiphysis. Latent bone cysts (recognized in later life) may be found in the middle third of the shaft.

Pathology—Little can be added to the discussion of this phase of bone cyst in the monograph by Geschickter and Copeland, so that no detailed consideration will be made of it here.

It is our belief that bone cyst and giant-cell tumor are closely connected conditions which have more than mere radiographic and histological similarity to suggest this relationship. We have operated upon several typical bone cysts in which the microscopical appearance of many areas was quite typical of osteitis fibrosa but in other areas the structure seen in typical examples of giant-cell tumor was found. It would make considerable difference which of these areas was found, if the diagnosis were allowed to rest solely on histological grounds. This thought is not new apparently for John B. Murphy as early as 1913 remarked that "in fibrocystic disease the diagnosis may as well be made by the X-ray examination as by the microscope. The surgeon who depends upon frozen sections for diagnosis in bone tumors of central origin will come to grief."

We believe that the essential differences between bone cyst and giant-cell tumor lie in the age of the individual and in the location of the lesion. The phase of bone destruction in the epiphysis meets with less resistance and evokes a less aggressive healing phase (defensive reaction of cortical bone) than it does in the metaphysis. It is more active in the young adult than in the child. Whether this is due to the fact that there is in the growing child a more active bone reparative function than is present in the young adult, or solely to the fact that before the epiphyses have united the lesion attacks the metaphysis and is prevented from involving the epiphysis by the presence of the cartilage layer at the epiphyseal line is a matter of speculation. Whatever the explanation it is a fact that in the metaphysis the arrested lesion, bone cyst occurs, whereas in the epiphysis the progressive or unchecked lesion giant-cell tumor is found.

Age—Of the twenty-six cases in this series, nineteen were under twenty years of age at the time of first admission to the clinic. The youngest was a boy of four the oldest a woman of forty-one. The average age was 15.9 years. If the oldest patient be excluded (and her symptoms actually began with fracture twenty-three years prior to admission) the average age of the rest would be 14.9 years.

Sex—There were fifteen males and eleven females. Most writers agree that the condition is more common in males. This might be explained on the greater likelihood of injury to the bone in the growing boy.

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Trauma—Onset with symptoms of pathological fracture, in most instances after trivial injury, was noted in seventeen of the twenty-six cases, there were four cases in which trauma preceded the onset of symptoms by a considerable period. In two cases without fracture radiograph taken two days after the injury showed the presence of a cyst. In eight of the patients no history of injury could be elicited.

Duration of Symptoms—Of the twenty-six cases, four sought treatment

SUMMARY 26 CASES OF BONE CYST

No	Case	Age	Sex	Date	Sits	third	Trauma	Fracture	Complaint	Duration	Treatment	Result	
1	P C	22	M	6/29/32	L	Humerus	upper	yes	0	swelling	2 years	Cur	Good
2	P T	9	M	2/ 7/33	L	Humerus	upper	yes	at onset	pain	6 days	Fr	#
3	L D	23	F	11/22/32	L	Phalanx	middle	yes	0	pain	5 years	Cur	Good
4	F P	14	M	12/16/24	R	Femur	upper	yes	at onset	pain	1 day	Fr + Cur	Good
5	A S	14	M	2/24/30	L	Radius	lower	yes	later	swelling	1 year	Fr + Irr	Good
6	C D	15	M	3/25/20	L	Humerus	upper	0	at onset	pain	6 weeks	Irr + Cur	Good
7	H F	19	F	10/30/25	L	Femur	upper	0	0	pain	5 months	Irr	Good
8	M L	10	M	12/ 2/31	L	Femur	upper	0	0	limp	3 months	Fr + Cur	Good
9	H Q	20	F	10/28/29	R	Humerus	lower	yes	at onset	pain	1 day	Fr + Irr	Good
10	R P	5	M	6/ 9/31	R	Humerus	upper	yes	at onset	pain	3 weeks	Fr	Good
11	A C	27	F	9/13/30	L	Humerus	middle	0	0	pain	4 years	Cur	Good
12	L L	13	F	11/ 4/22	R	Ulna	lower	yes	0	pain	10 month	Cur	Good
13	J M	8	M	6/19/24	R	Femur	upper	yes	later	pain	2 years	Irr + Fr*	Good
14	J P	16	M	9/ 7 26	R	Radius	lower	0	0	pain	2 years	Irr	Fair
15	W M	18	M	5/13/32	R	Fibula	upper	0	at onset	pain	1 day	Fr + Cur	lost
16	S R	6	F	9/11/25	L	Femur	upper	yes	at onset	pain	5 days	Cur	Good
17	C B	9	F	11/14/28	L	Femur	lower	yes	0	pain	2 days	0	lost
18	M C	10	F	12/10/31	R	Tibia Fibula	lower upper	yes	at onset	pain	2 days	Fr + Cur	Good
19	A H	18	M	11/ 9/31	R	Humerus	upper	yes	later	pain	2 weeks	Fr + Cur	Good
20	F J	35	M	4/29/31	L	Rib 7	middle	yes	at onset	pain	2 days	Irr	Fair
21	B W	41	F	4/10/32	R	Femur	middle	yes	at onset	pain	23 years	Cur + Gr	Fair
22	R C	22	F	8/30/30	L	Femur	upper	0	0	pain	2 years	Irr	Good
23	S B	13	M	1/25/28	R	Humerus	upper	yes	later	pain	6 years	Fr	Good
24	H G	13	M	1/ 8/26	L	Femur	upper	0	later	pain	1½ years	Fr	Good
25	P F	9	F	3/11/30	R	Humerus	middle	yes	at onset	pain	1 day	Cur + Gr	Good
26	L P	4	M	1/27/30	R	Femur	upper	yes	later	pain	8 months	Cur + Gr	Good

Too recent to judge result

* Treated by irradiation, later for pathological fracture, then by osteotomy to correct deformity

TREATMENT Fr=for fracture Cur=ouretags Irr=irradiation Gr=bone graft

with the appearance of the first symptom and five more were admitted to the clinic within a week after the first symptom. In seven cases the interval was between one week and one year, and in ten cases from one to twenty-one years. Thus it is apparent that the majority of patients seek medical attention early, because of fracture, or else after the lapse of at least a year because the symptoms are so mild and cause so little disability.

Bone Involved—The femur was the affected bone in ten cases, the humerus in nine, the radius and fibula twice each, and the tibia, ulna, rib, and phalanx of finger but once each. The upper end of the femur, humerus

and fibula was the site most often affected, while in the ulna and radius cases the lower end only was involved. The middle of the shaft of the humerus and the femur was the site of the cyst in one instance each, but it seemed to us that the ages of the patients, twenty-seven and forty-one, made it likely that the growth of bone had progressively shifted the cyst towards the centre of the shaft.

Treatment of Bone Cyst — The treatment of solitary bone cyst is surgical. There is a striking agreement upon this point among the many who have made important contributions to our knowledge of this disease. Among these may be mentioned von Haberer, Hoffmeister, Schlang, Tavernier, Mouchet, Dujarier, Hertz-Boyer, Ombrédanne, Bloodgood, Sisk, Painter, and others. Sisk states, "in the treatment of osteitis fibrosa cystica the greatest economy of time is served by conservative surgery at the time the lesion is discovered. The uniform success obtained by surgery, with a comparatively short convalescence period, argues against long periods of watchful waiting." While all agree that conservative surgery is indicated, there is apparent a wide range of procedures that have been suggested, some of which cannot be regarded as conservative.

When a fracture has occurred in a previously unrecognized bone cyst, manipulation to obtain satisfactory position, if necessary, followed by immobilization during the healing period, is in most cases all that is necessary to obtain a satisfactory result. We know of no case in which union was not promptly attained. If fracture should fail to heal the cystic area, an operation could be done at a later date.

When recognized before a fracture has occurred, it would seem, on theoretical grounds at least, that the deliberate production of a fracture under anæsthetic with manipulation and immobilization was a justifiable procedure, as exemplified by those cases in which a satisfactory end-result followed a spontaneous fracture.

We recommend operative interference, which consists in exposing the involved area, cutting a large enough window to give access to the entire cavity and carefully curetting the entire contents down to cortical bone. The cavity should then be swabbed out with an escharotic, such as carbolic acid, alcohol, or zinc chloride saturated solution, followed by irrigation with normal saline solution. The rectangular segment of cortical bone removed in exposing the cyst may then be placed in the cavity as a graft, and the wound closed in layers without drainage. The practice of packing the cavity of a bone cyst (or a giant-cell tumor) is mentioned only to be condemned, most of the surgical catastrophes have been due to infection following this procedure. The cavity undoubtedly fills with blood clot into which osteoblasts later progress and form new bone. Unlike hematomas elsewhere, the blood clot in a bone cyst or giant-cell tumor cavity rarely becomes infected, if the wound is properly closed. When packing is used, infection is apt to occur. We seldom use bone chips or small osteoperiosteal grafts, rarely a massive bone graft may be necessary.

X-ray therapy may be employed, but in our opinion the results are more uncertain and less satisfactory than those obtainable by surgery. One should also consider the possibility of damaging the growth centres by over-irradiation.

In this series of cases there was a wide variety of methods of treatment which can readily be ascribed to the fact that the cases were treated in three different hospitals.

Prognosis—The prognosis for a satisfactory anatomical and functional result in bone cyst is good. The danger to life and limb should be non-existent. No case in this series of simple bone cyst required a mutilating operation and there was no mortality. Fracture seldom produces marked deformity. Healing of the fracture is prompt, there were no cases in this series of delayed union or non-union. Where fracture occurs repeatedly (in two of our cases twice), there is usually shortening as an end-result. In the upper extremity this may have little significance, but in the femur it may require the use of measures to compensate for this shortening. In weight-bearing bones, if the process is left unsupported for a considerable period and bending is permitted, the deformity may be of serious consequence from a functional standpoint, as illustrated in Case XIII.

Results—The end-results are briefly summarized in the table below. Curettage, with or without additional procedures, was the method used in thirteen cases, with twelve good and one fair result. Treatment of the fracture only gave good results in the four cases so treated. Irradiation alone, or combined with other procedures, was used in eight instances with five good results, two fair, and one not traced.

RESULTS

Treatment	Good	Fair	Poor	Not Traced
1 No Treatment	0	0	0	1
2 Treatment of Fracture Only	4	0	0	0
3 Curettage Alone	5	0	0	0
4 Curettage After Fracture	5	0	0	0
5 Curettage plus Graft	2	1	0	0
6 Curettage plus Irradiation	1	0	0	0
7 Treatment of Fracture plus Irradiation	2	0	0	0
8 Irradiation Alone	2	1	0	1
9 Prolonged Irradiation—Later Fracture—Mal-union Requiring Osteotomy	0	1	0	0
Totals	21	3	0	2

CASE SUMMARIES

CASE I—P. C., male, aged twenty-two, was admitted to Memorial Hospital June 29, 1932, with a history of having been struck on the upper left arm with a packing case two years previously. His only complaint was of a swelling in the region injured. Clinical diagnosis was healed bone cyst of the upper end of the left humerus, X-ray diagnosis was chondrosarcoma. While under observation he began to complain of pain in the affected region, so curettage was performed January 25, 1933, with pathological findings of

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chronic osteitis When examined five weeks later the wound was well healed and the function of the arm was excellent

CASE II—P T, aged nine, was admitted to Lincoln Hospital February 7, 1933, two days after he had injured his left arm, sustaining a pathological fracture through a bone cyst in the upper end of the left humerus as revealed by X-ray films He was treated as for simple fracture and a good result is to be expected, though it is too early to make a positive statement

CASE III—L D, female, aged twenty-three, was admitted to Lincoln Hospital November 22, 1932, with pain and swelling of the left middle finger persisting for five years following injury to the finger X-ray films showed a bone cyst in the middle of the proximal phalanx This was curetted and carbolyzed November 22, 1932, with an excellent result The pathologist reported osteitis fibrosa cystica circumscripta

CASE IV—F P, male, aged fourteen, was admitted to Lincoln Hospital December 16, 1924, because of pain in the hip occurring after a fall while at play in a gymnasium X-ray film showed a fracture of the upper end of the femur through a bone cyst He was treated as for simple fracture first and two months later curettage was performed This was followed by wound infection, which subsided in a month, and a walking Thomas caliper was worn for six months Following this he had an excellent anatomical and functional result

CASE V—A S, male, aged fourteen, was admitted to Memorial Hospital February 24, 1930, with a history of injury to the wrist one year previously and a more severe injury nine months later, when X-rays were taken which showed a fracture through a cystic area in the lower end of the radius A splint was applied and X-ray treatments were given Four more X-ray treatments were given at Memorial Hospital and the splint was removed An excellent result was secured and three years later no appreciable difference in the two wrists could be demonstrated

CASE VI—C D, male, aged fifteen, was admitted to Memorial Hospital March 25, 1920 Six weeks previously he had sustained a fracture through a bone cyst in the upper end of the left humerus and the cyst had been curetted and the fracture set Radium-pack treatments were given at Memorial Hospital after the wound had healed, and ten years later the patient was symptom-free and function of the arm was excellent

CASE VII—H F, female, aged nineteen, was admitted to Memorial Hospital October 30, 1925, with a history of pain in the left thigh of five months' duration and difficulty in walking for one month X-ray diagnosis was chondrosarcoma of the upper end of the shaft of the left femur Clinical diagnosis was osteitis fibrosa cystica X-ray and radium treatments were given for three months with prompt improvement and two years later clinical and X-ray evidence showed an excellent result

CASE VIII—M L, male, aged ten, was admitted to the Hospital for Ruptured and Crippled December 2, 1931, with a history of a limp of three months' duration X-ray films revealed a multilocular cyst in the upper end of the left femur This was curetted and a plaster spica applied The spica was removed nine weeks later and weight-bearing allowed Six months later clinical and X-ray examination showed an excellent result Pathological examination of the curetted material showed fibrous connective tissue

CASE IX—H Q, female, aged twenty, was admitted to Memorial Hospital October 28, 1929 She had fallen on the stairs and struck her right elbow, sustaining a fracture of the humerus into the olecranon fossa A splint was applied and in radiographs made two weeks later a cyst was observed at the site of fracture Two X-ray treatments were given There was good union of the fracture and rapid healing of the cyst, and the anatomical and functional result is excellent

CASE X—R H, male, aged five, was admitted to Memorial Hospital June 9, 1931, three weeks after he had fractured his arm through a cystic area in the upper end of the right humerus The arm had been put up in abduction in a plaster spica and no other form of treatment was employed The fracture healed nicely and ten weeks after the injury the patient was symptom free and exhibited perfect function of the arm

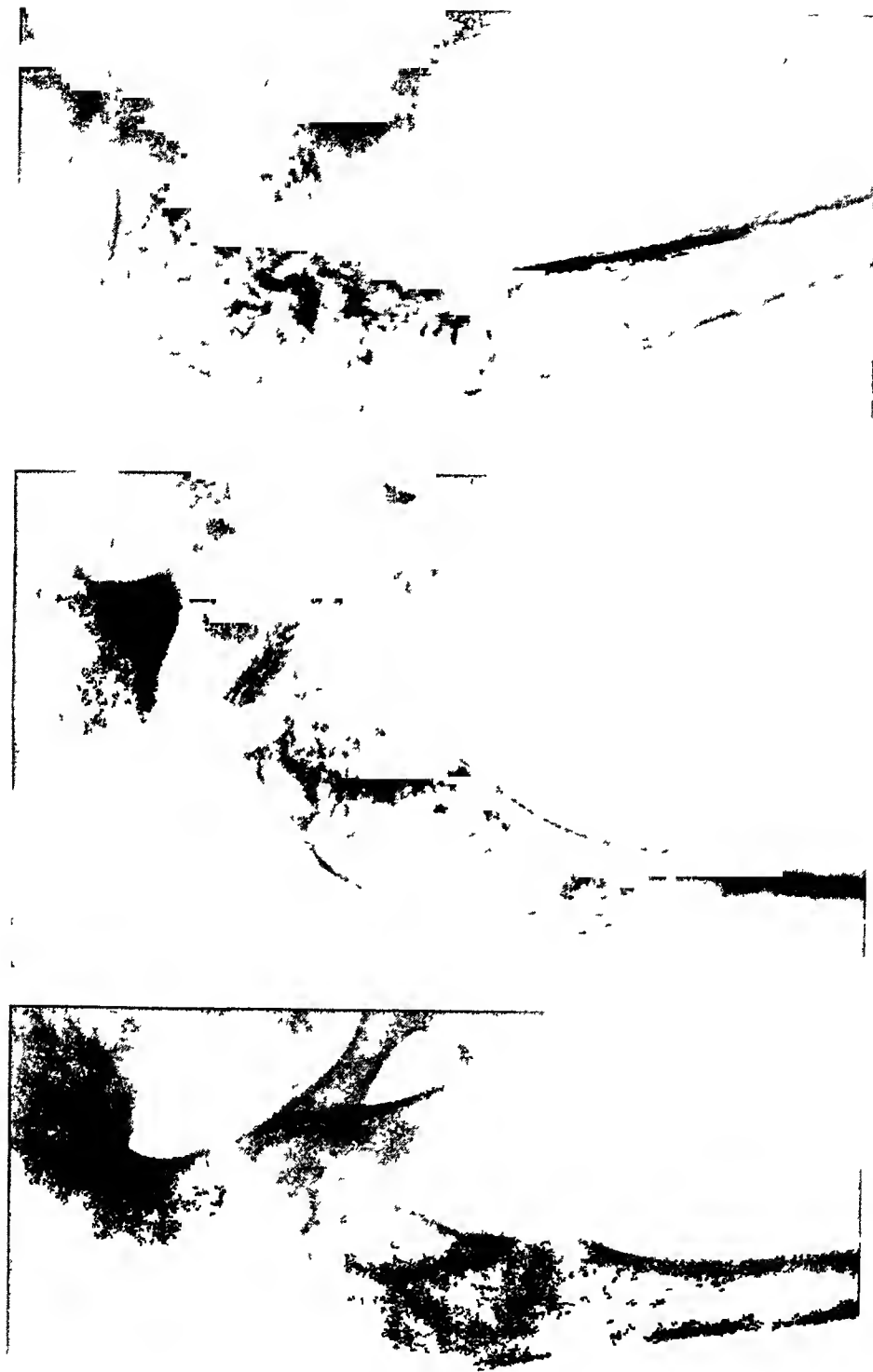


FIG 2

FIG 2—(Case VIII) Shows degree of involvement,

FIG 3

FIG 3—(Case XIII) Showing condition three years later X-ray therapy in the interval

FIG 4

FIG 4—(Case XIII) Bone cyst in upper femur—boy of eight years—showing condition at time of admission

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CASE XI—A C, female, aged twenty-seven was admitted to the Hospital for Ruptured and Crippled September 13 1930 with a history of a dull aching pain in the left arm X-ray films revealed a cystic area in the middle of the shaft of the humerus Curettage was performed Pain was relieved but ten months later there was evidence of renewed activity, so a second curettage was performed and was followed by complete healing and return to perfect function Pathological report on the first operation was benign central chondroma and on the second was chronic osteitis

CASE XII—L L female aged thirteen was admitted to the Hospital for Ruptured and Crippled November 4 1932, with a history of injury to the wrist ten months previously, followed by persistent swelling and continued pain after a second injury six



FIG 5



FIG 6

FIG 5—(Case XIII) Shows appearance one year later (six years after first admission) Lesion apparently healed but deformity and shortening marked An osteotomy was later performed at the Hospital for Ruptured and Crippled

FIG 6—(Case XIII) End result eleven years after first admission and three and a half years after osteotomy Patient now aged eighteen Shows shortening, restoration of neck and head in relation to shaft, also site of osteotomy performed for deformity

months later X-ray diagnosis was giant-cell tumor of the distal end of the ulna, clinical diagnosis was bone cyst. The area was curetted and followed by primary wound healing and rapid return to full function

CASE XIII—J M, male, aged eight, was admitted to Memorial Hospital June 19 1924 At the age of six he had been struck over the right thigh with a baseball and this was followed by a persistent limp, weakness of the leg and occasional pains in the thigh Later an X-ray film was made and revealed a cystic area in the upper end of the femur X-ray therapy was given in July, 1924 and again in October, 1927 In August, 1928, he fell and fractured his femur through the involved area (Figs 2 3, and 4) He was treated by means of a plaster spica, but there was marked deformity and shortening, necessitating an open operation for correction one year later Recent examination shows

him free from pain, but he walks with a moderate limp and shows four inches of measured shortening in the affected limb (Figs 5 and 6)

CASE XIV—J P, male, aged sixteen, was admitted to Memorial Hospital September 7, 1926, complaining of pain in the right wrist of two years' duration. Radiographs revealed a bone cyst in the distal end of the radius. One X-ray treatment was given and increase in the pain noted two weeks later. The patient did not return to the clinic and could not be traced.

CASE XV—W M, male, aged eighteen, was admitted to Memorial Hospital May 13, 1932. While picking up two five-gallon cans of oil he felt a sudden pain in his leg. X-ray films revealed a fracture through a bone cyst in the upper end of the right fibula. The cyst was curetted and a cast applied for nine days. There were no further symptoms and a year later function was normal (Fig 7).



FIG 7—(Case XV) Healing of a bone cyst in which a spontaneous fracture was the first symptom. Curettage. Excellent anatomical, functional and economic result.

CASE XVI—S R, female, aged six, was admitted to Lincoln Hospital September 11, 1925, complaining of pain in the hip and inability to walk for the past five days following an injury to the hip. X-ray films showed a pathological fracture through a cyst in the upper end of the shaft of the left femur. This was curetted, the wound healed per primam and the patient was allowed to walk without crutches in two months. A year later anatomical and functional result was excellent.

CASE XVII—G B, female, aged nine, was admitted to Lincoln Hospital November 14, 1928. Two days previously she had twisted her knee and X-ray films, taken for possible fracture, revealed a bone cyst in the lower end of the left femur. Patient was kept in bed for two weeks and no other treatment was adopted. She was discharged symptom-free and has never returned for follow-up examination.

CASE XVIII—M C, female, aged ten, was admitted to Lincoln Hospital December 10, 1931. Two days before admission patient fell and injured her right ankle. X-ray films show a pathological fracture through a bone cyst in the lower end of the right tibia, and a small cystic area in the upper end of the right fibula. Skeletal films were taken and revealed no other cystic areas. The lesion in the right tibia was curetted and a plaster cast applied. Five weeks later she was discharged from the hospital without her cast and, when examined two months ago, had an excellent result.

CASE XIX—A H, male, aged eighteen, was admitted to Memorial Hospital November 9, 1931. Two months previously he had wrenched his shoulder. After the pain and swelling disappeared he again injured his shoulder with more severe symptoms of pain and disability, and X-ray films revealed a bone cyst in the upper end of the right humerus, with a pathological fracture. The cyst was curetted and the arm put up in abduction in a plaster spica. An excellent result was obtained.

CASE XX—F J, male, aged thirty-five, was admitted to Memorial Hospital April 29, 1931, two days after he had struck the left side of his chest in a fall. X-ray films revealed a recent pathological fracture through a cystic area of apparently long duration in the eleventh rib. Two X-ray treatments were given over the involved area with marked relief of pain, though the patient continues to have some discomfort at the site of the lesion.

SOLITARY BONE CYST

CASE XXI—B W, female, aged forty-one, was admitted to the Hospital for Ruptured and Crippled April 10, 1932 Twenty-three years ago the patient fell on a dance floor and fractured the right femur This apparently healed without complication until six months ago (eighteen years later), when he began to have pain at the site of the original injury An X-ray film revealed a bone cyst in the middle of the shaft of the right femur Eight X-ray treatments were given, but pathological fracture through the cyst occurred The cystic area was then curetted and a bone graft from the right tibia inserted A plaster spica was applied for eight weeks and then the patient was permitted to walk with crutches Six months after operation full weight-bearing was allowed Progress has been satisfactory While there is 4 centimetres of shortening and a con-



FIG 8



FIG 9

FIG 8—(Case XXIII) Healed bone cyst Appearance nine years after first, two years after second, pathological fracture Perfect function Shortening of humerus of five centimetres Gives no symptoms

FIG 9—(Case XXIV) Showing healing, with some coxa vara deformity, nine months after treatment of a bone cyst with pathological fracture of the neck of the femur Treatment—immobilization, after reduction, in Whitman plaster spica

sequent slight limp, it is too early, eleven months after operation, to judge of the end-result

CASE XXII—R C, female, aged twenty-two, was admitted to Memorial Hospital August 30, 1930, with a history of pain in the thigh of two years' duration, becoming more severe and not responding to eight X-ray treatments X-ray films revealed a cystic area in the upper end of the left femur and further X-ray treatments were given with later evidence of bone repair and relief of symptoms

CASE XXIII—S B, male, aged thirteen, was admitted to Memorial Hospital January 25, 1928 In 1922 the patient injured his right arm while at play and an X-ray film taken at that time revealed no fracture, but when reviewed later was found to show a bone cyst in the upper end of the right humerus He remained symptom-free for six years, but began to complain of pain and disability, one month before admission He was

kept under observation for ten months, then, while playing handball, sustained a pathological fracture through the cystic area. This healed rapidly in four weeks, but with two inches of shortening (Fig 8). The shortening has remained unchanged, but the patient exhibits full range of motion at the shoulder and excellent function of the arm.

CASE XXIV—H. G., male, aged thirteen, was admitted to the Hospital for Ruptured and Crippled January 8, 1926, with a history of pain in the thigh of insidious onset and one and a half years' duration. X-ray studies showed a cystic area in the upper end of the left femur with pathological fracture (Fig 9). A plaster cast was applied for four weeks and an excellent anatomical and functional result was obtained.

CASE XXV—P. F., female, aged nine, was admitted to the Hospital for Ruptured and Crippled March 11, 1930, immediately following an injury to her right arm. X-ray revealed a cystic area in the mid-shaft of the right humerus. This was curetted and a bone graft inserted. Recent examination reveals an excellent anatomical and functional result.

CASE XXVI—I. P., male, aged four, was admitted to the Hospital for Ruptured and Crippled January 27, 1930, complaining of pain in the hip and persistent limp following an injury eight months previously. X-ray examination showed a bone cyst in the upper end of the right femur. This was curetted and bone grafted, and recent examination shows an excellent result.

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POST-TRAUMATIC ACUTE BONE ATROPHY (SUDECK'S ATROPHY)

BY FRASER B GURD, F R C S (C)

OF MONTREAL, CANADA

FROM THE MONTREAL GENERAL HOSPITAL

As is well known it is the rule to find that the bones of extremities which have been put at rest for any considerable length of time, for any reason, such as prolonged bed-confining illnesses, fractures, or paralyses, become less resistant to the X-ray and consequently throw a less dense shadow, and that they are smaller than normal. Such a condition of bone atrophy is of comparatively little importance since, upon resumption of function, the bones gradually comparatively quickly, and surely regain their normal density, and increase in diameter. In the meantime, moreover, there are no symptoms experienced by the individual referable to the absorption of calcium from the bones.

Cases are occasionally observed, however, which demonstrate atrophy, or osteoporosis, of an entirely different type. In the first place, the bone changes occur rapidly, with few exceptions they are exhibited within a few days or weeks following injury. The original traumatism is, as a rule, not severe, but, it would appear, is usually repeated either as the result of a second or third trivial accident, or as the result of irritation in the course of treatment. Characteristically, the original injury is in the neighborhood of a joint, more especially those parts in which many joint surfaces are seen in close association, such as the wrist and tarsus. In this type of atrophy, roentgenograms show a very typical patchy (*flächlich*) or "moth-eaten" appearance of the bones in the immediate vicinity of the traumatized area and, also, in the bones distal to the region which has apparently been hurt.

The author is of the opinion that the importance of acute bone atrophy, as a cause of temporary disability, is not sufficiently well recognized by the majority of surgeons, in that innocent persons are accused of malingering, and also that a small number of surgeons prove their unfamiliarity with the condition by recommending too heroic measures, *e g*, amputation, for its treatment. The opinions expressed under oath by surgeons of experience and authority, in connection with the results of injury leading to litigation, in which the author has been interested, prove these facts to be true. In this contribution cases of acute bone atrophy following trauma will alone be considered.

A recent article by Fontaine and Herrmann,¹ published from Leriche's Clinic in Strasbourg, describes the condition under the title of "Post-Traumatic Painful Osteoporosis." The application of this name to the condition is significant, and, except for the fact that it is cumbersome, might well be adopted. Fontaine and Herrmann's article is noteworthy in that

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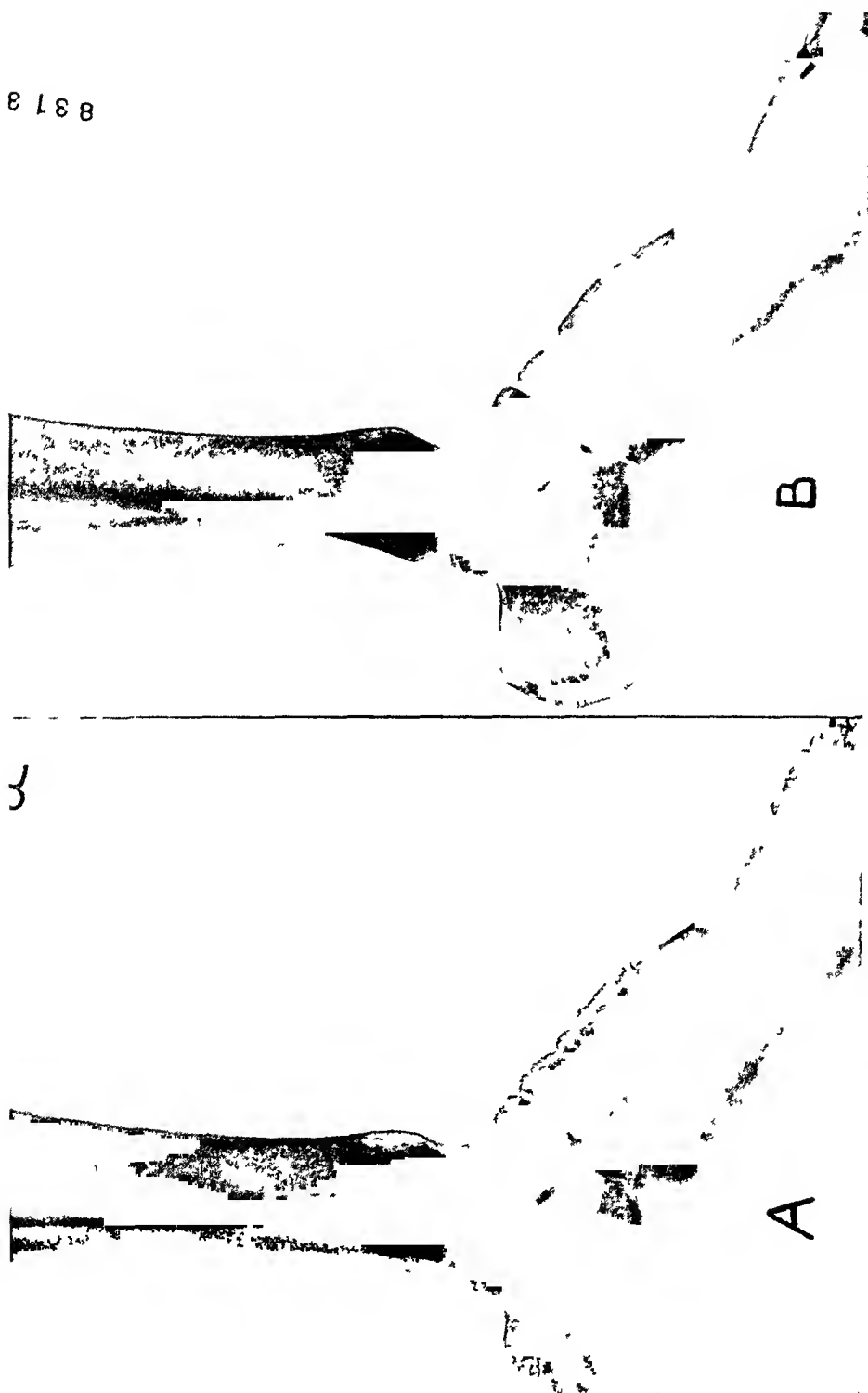


Fig 1 —(Case IV) (P.L.) Rontgenograms of both feet three months after fracture of sesmoid. Note typical patchy osteoporosis of right foot (A)

ninety-one references are included, of which but nine (only one, Noble and Hauser,² deals in fact with acute bone atrophy), refer to articles published by English-speaking authors. Of the remainder, forty-one have their origin in France, and thirty-eight made their appearance in German literature. Eight articles, published between 1923 and 1930, are from the pen of Leriche himself.

Acute bone atrophy of a specific type was first described by Sudeck³ in 1900, during the following two years this author made further contributions^{4, 5}. Although, in the intervening years since that time, a certain amount of data have accumulated with reference to the symptomatology and pathological findings, and, to a limited extent, with reference to treatment, no adequate explanation of the cause of the condition has been generally accepted.

Willich,⁶ following Beck, classifies the etiological factors of bone atrophy as follows: (1) Atrophy due to deficient nutrition. (2) Disuse atrophy. (3) Senile atrophy. (4) Acute reflex (*reflektorische*) atrophy (Sudeck's). (5) Neuropathic atrophy.

Willich, in a recent article, draws attention to the great clinical interest in the question of bone atrophy. Despite the number of contributions by German writers on the subject since Sudeck's first article, the matter, he says, is not yet explained.

At the 1921 (16th) and 1928 (23rd) Congresses of the German Orthopedic Association, the main topic under consideration was the condition discussed in this contribution. In 1928, the subject was opened by Beck,⁷ who reviewed our knowledge of the condition up to the present. He suggested that disturbances in the circulation, particularly in the sense of an increased capillary and venous pressure, which results in a local accumulation of carbon dioxide, stimulates osteoclastic absorption of the bone. He indicated that Sudeck's atrophy seems to be due to a collateral hyperæmia. He stressed the importance of œdema, cyanosis, and atrophy of the skin, changes which are always present in the presence of acute bone atrophy, as indicating a disturbance in circulation. It will be noted that these views are in agreement with those recently brought forward by Grieg,⁸ of Edinburgh, in that he believes calcium absorption from bone to be due to a diminution of blood supply.

Beck's paper was discussed by Grashey, who stressed the importance of identical technic in making roentgenograms of similar parts, Rabl, who supported the theory of inactivity, and by Spitzzy, Koenigswieser, Schede, Hilgenreiner and Goecke. Koenigswieser names the condition of acute bone atrophy traumatic osteomalacia.

Diagnosis and Clinical Course—The clinical appearance of a case of acute bone atrophy is fairly typical. Within a few days after the reception of the injury, usually trivial or relatively so, the foot or hand, which has been somewhat swollen and painful immediately following the injury, becomes progressively more swollen and more painful. Although it is possible to palpate the pulse pressure in the blood-vessels in the neighborhood of the ankle or wrist, it appears evident from an examination of the limb that the

capillaries are engorged and that an increase in interstitial tension has taken place. The appearance of the affected part indicates an atrophy of tissues other than the bones. The skin becomes smooth, tends to lose its characteristic markings, and may become "glossy."

The joints rapidly become stiff, and movements, either active or passive, are extremely painful. Although it is possible to induce diminution in swelling by means of posture, this effect is brought about only with difficulty, in that prolonged elevation is required. Absolute rest to the member usually, or always, is followed by relief from pain, even a minimal attempt at movement, either active or passive, or unprotected weight-bearing, is extremely ill-borne. That atrophy of the ligamentous tissues accompanies the bony lesion is proven by the likelihood of subluxation, either grossly as in Case VII or by the development of extensive and painful flat foot. That the cartilaginous ends of the bones may atrophy is shown by the exhibition of bony ankylosis in certain cases, as in some reported by Fontaine and Herrman.

Röntgen examination made within a few weeks from the date of injury shows a very characteristic "patchy" atrophy of the bones in the immediate neighborhood of the injury and also in the bones distal to the site of injury. To a less marked extent, similar changes are seen in the bones immediately proximal to the traumatized area. In the case of injuries about the ankle and foot, it is usual to find the lower fifth of the tibia and the distal extremity of the fibula involved in the atrophic process, likewise, the lower end of the radius is involved in the case of carpal and hand injuries. In the case of the shoulder, both scapula and upper part of the humerus are seen to be the site of osteoporosis.

Sudeck, in his first contributions, divided the disease into two stages (a) the acute, and (b) the chronic form. It is the acute stage which, I believe, is of most importance, since in the first place it is more readily diagnosed and in the second place is, I believe, more susceptible to conservative treatment. In the article by Fontaine and Herrmann, previously referred to, they have reported a number of cases, more especially at the chronic stage, and, it would appear, have been successful in indicating at least one form of treatment for such cases. They divide the disease into three stages (a) the onset, (b) the height of the disease, and (c) the reorganization. It is in what they refer to as the "onset of the disease" that the typical patchy appearance of the bones is noted on the roentgenogram. At the "height of the disease" the irregular areas of rarefaction disappear and the bones become uniformly permeable to the Röntgen-ray. During the "period of reconstruction" or reorganization, there is a slow reappearance of calcium in the bones. Fontaine and Herrmann state that in most cases complete recalcification never takes place. In the author's experience this is probably correct, although it is evident that complete return of function may be expected without an absolutely normal X-ray appearance.

Fontaine and Herrmann express the opinion that the oscillometric index

POST-TRAUMATIC ACUTE BONE ATROPHY

is of great value in determining the existence of the vasomotor disturbance. They report that in seven cases of osteoporosis of the bones of the wrist, the oscillations were six times stronger in the affected forearm than at the same level in the normal forearm, and that in six cases of the disease about the ankle they found a marked increase in the oscillations of the lower third of the affected leg, in five cases. The author has not employed this method of examination.

Clinical diagnosis is dependent upon the presence of the signs indicated in the first paragraph of this section, particularly when the loss of function and pain are out of all proportion to importance of the original trauma. Radiological differentiation is most important in the acute state since tumor

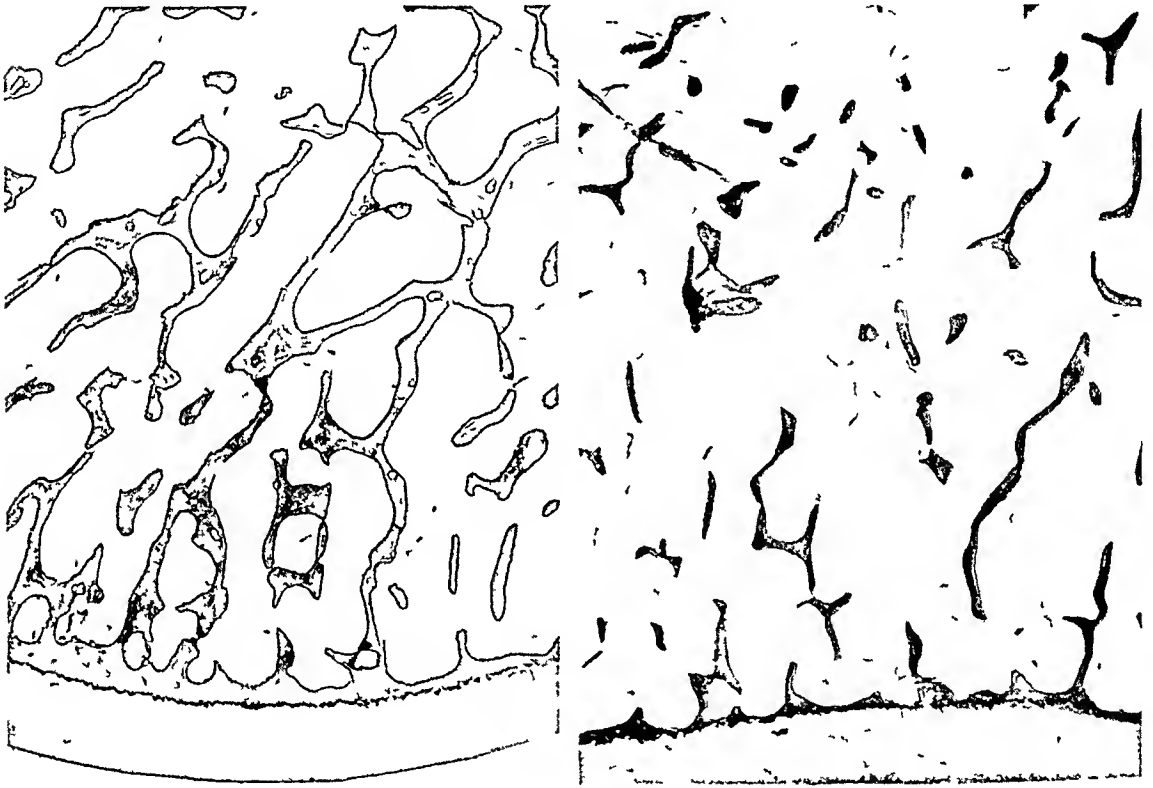


FIG. 2—Photomicrograph of carpal bones from both normal and diseased wrists. In this case there was roentgenological evidence of fully developed acute bone atrophy of right hand. (Fontaine and Herrmann) (Courtesy ANNALS OF SURGERY)

may be considered. It is during the second stage, or height of the disease, that the diagnosis of tuberculous osteo-arthritis is likely to be made.

Pathology—Comparatively few observers have had the opportunity of examining the porotic bones, either in the gross or microscopically. Vialleton⁹ (1922) reported the histological examination of two cases and found a disappearance of all the transverse striæ and a diminution of the longitudinal striæ. The Haversian canals become very large and the cortex becomes very thin. The bone absorption is apparently not the result of osteoclastic activity since these specific phagocytes were not seen in any of the preparations. It would appear that there is a uniform loss of bony substance and not merely a depletion of the mineral salts of the bone.

Fontaine and Herrmann have had the opportunity of examining bones

from two cases I am indebted to Dr Lewis S Pilcher, Editor of the ANNALS OF SURGERY, for permission to republish photomicrographs showing the difference in the histological structure of a carpal bone from the right hand in which there was roentgenological evidence of fully developed osteoporosis and the histological structure of the carpal bone from the opposite hand. It will be noted that there is a diminution in the number and thickness of the bony lamellæ in the osteoporotic hand.

Muscle atrophy, as well as atrophy of the subcutaneous tissues, is present. The skin is thinned and may be glossy. Atrophy of the ligamentous tissue would appear to be invariably present and, as in Case VII, such atrophy was so marked that subluxation of the subastragaloid joint occurred. Synostosis of the carpal bones, as observed at Leriche's Clinic, would appear to prove atrophy of cartilage.

Site and Frequency—Acute bone atrophy is rarely, if ever, noted in the diaphyses of the long bones. It is most frequently seen in the short bones of the carpus and tarsus. It is not infrequently present in the epiphyses of the metatarsals, metacarpals and phalanges. As a rule, in cases in which carpus or tarsus is involved, the epiphyseal ends of the bones of the forearm or leg exhibit a characteristic halisteresis. If the condition described by Kummell in 1895 of atrophic changes in the vertebral bodies be, in fact, as seems probable, an example of the same condition, the phenomenon of acute bone atrophy is found most commonly in the foot and ankle, somewhat less frequently in the hand and carpus, and also in the spine. Hitherto, except for a few questionable cases, there has been no general recognition of the condition elsewhere in the body, although Noble and Hauser² report cases in the neighborhood of the knee-joint. A recent case seen by the author indicates that a similar phenomenon is exhibited following injuries in the neighborhood of the shoulder-joint. Cases of painful osteoporosis about the shoulder have also been reported from Leriche's Clinic. Strasbourg Schuller¹⁰ (1929) reported typical examples of post-traumatic rarefaction of the skull. Fontaine and Herrmann report having seen one case exhibiting this condition.

That the condition is an unusual one is evident from the fact that during twelve years, namely, from 1912 to 1924, only forty-eight cases, diagnosed as acute bone atrophy, were treated at The Mayo Clinic². Of these cases, forty-one were in the lower limbs, six in the upper limbs and one in the spine.

Noble and Hauser state that of these cases, twenty-seven followed minor trauma, twelve were either spontaneous or due to an unrecognized trauma, and two were due to fractures of both bones of the leg. Of the six cases which occurred in the upper limbs, five were a complication of Colles fracture and one followed a manipulation of the shoulder complicated by a traumatic neuritis of the ulnar nerve. Of the cases seen at The Mayo Clinic, the average time elapsing between the receipt of the trauma and examination was three and one-half months. The one case of Kummell's disease occurred in a man aged forty-two, eight weeks after a direct trauma to the back.

TABLE I

Analysis of Cases—Fontaine and Herrmann

Case	Sex	Age	Time after Injury First Seen	Nature of Injury	Part Affected	Treatment	Result
II	M	57	4 mos.	Contusion, hand	II and	Ganglionectomy	Died
III	M	57	3 mos	Fracture, shoulder	Humerus, elbow and hand	Ganglionectomy (?)	Died six months later complete
IV	M	17	6 mos	No history, tumor	Hand (Roentgen diagnosis—tuberculous osteo arthritis)	Peri-articular symp thectomy	Cure
V	M	47	3 mos	Contusion, hand	Hand (Roentgen diagnosis—tuberculous osteo arthritis)	Peri-articular symp thectomy	Ankylosis wrist joint Functional cure
VI	F	54	5 wks	Spr un, wrist	II and (Roentgen diagnosis—tuberculous osteo arthritis)	Peri-articular symp thectomy	Function II cure Radiological recalcification incomplete
VII	F	59	10 wks	Colls	Hand	Peri-articular symp thectomy	Six months' cure, both functional and radiological
VIII	F	65	2 mos	Colls	Hand	Peri-articular symp thectomy	From months' good recovery, both function II and radiological
IX	F	41	2 mos	Colls	II and		From months' functional recovery Radiological recalcification incomplete
X	F	65	5 mos	Contusion, hand	Hand, elbow and shoulder	Ganglionectomy	Slow recovery Five and one-half years functionally complete, radiologically incomplete
XI	M	45	12 mos	Contusion, foot	Foot	Ganglionectomy	From months' cure, functionally and radiologically
XII	M	27	3 wks	Contusion, foot	Foot	Peri-articular symp thectomy	Six months' cure, functionally and radiologically
XIII	M	25	2 mos	Contusion, foot	Foot (radiological diagnosis—tuberculous osteo arthritis)	Peri-articular symp thectomy	From months' cure
XIV	F	39	4 mos	Spr un, ankle	Foot	Peri-articular symp thectomy	Five months' clinical cure, slight recalcification
XV	F	27	several mos	Sprun, ankle	Foot	Peri-articular symp thectomy	Five months' clinical cure
XVI	M	38	3 mos	Operation, infection great toe	Foot	Peri-articular symp thectomy	Two years' cure, functionally and radiologically
XVII	F	31	2 mos	Foot's fracture	Foot (radiologic diagnosis—tuberculous osteo arthritis)	Peri-articular symp thectomy	Eight months' moderate cure, functionally and radiologically
XVIII	M	56	5 mos	Contusion, shoulder	Shoulder	Peri-articular symp thectomy	Two months' clinical cure
XIX	M	57	3 wks	Contusion, shoulder	Shoulder (slight decalcification only)	Peri-articular symp thectomy	Temporary relief, return of symptom (Operation diagnosis—J.B.C.)
XX	M	57	5 wks	Contusion, shoulder	Shoulder	Peri-articular symp thectomy	From months' clinical cure
XXI	M	30	4 mos	Contusion, shoulder	Shoulder (moderate infection humerus)	Peri-articular symp thectomy	No improvement
XXII	M	35	1 mo	Contusion, shoulder (complicated)	Shoulder	Peri-articular symp thectomy	Relief of pain, no improvement in movement

Fontaine and Herrmann report in detail a series of twenty-one cases, of which nine involved bones of the wrist, seven bones of the ankle, and five occurred in the vicinity of the shoulder-joint. An analysis of their cases is shown in Table I.

Boehler¹¹ pictures the condition and, although he makes no reference to its etiology or specific signs or symptoms, in characteristic fashion he indicates treatment. This is the same as that which has been employed by the author, namely, the application of a non-padded plaster case and weight bearing. The case is applied after all œdema has been gotten rid of by posture.

During the past six years, I have had under observation fourteen well-marked cases of bone atrophy. Of these, but one developed in a case under my own care (Case II). Of the fourteen cases, nine were complications of injuries, all more or less trivial, of the foot or in the neighborhood of the ankle-joint, four involved the hand, two followed Colles fractures, and two a simple contusion of the hand, in which no fracture was demonstrable. One case of shoulder-joint involvement has been recently seen. No case involving the knee-joint has been recognized as being a case of acute bone atrophy.

The accompanying table shows that the age limits among the author's cases were twenty-one and fifty-eight years. The average was 38.4 years. Fontaine and Herrmann's cases were between seventeen and sixty-five years, the average age being forty-four years.

Although only fourteen cases of well-established and typical bone atrophy have been seen by the author during the six-year period, and although other authors have hitherto reported but few cases, it is evident, I believe, that less typical lesions occur not infrequently, but since most methods of treating fractures, sprains and contusions are at least relatively useful in the care of cases of acute bone atrophy, the disease does not progress and the part returns to useful function even though at the expense of time.

Theories Regarding Causation—Sudeck,³ in his original paper, believed that the condition was a low-grade inflammation, but two years later, in 1902,⁵ he agreed with Kienbock,¹² who brought forward the theory of the condition being a manifestation of a trophoneurosis.

Vialleton⁹ (1922) examined tissues removed from atrophic bone. He failed to find any evidence of cellular infiltration of an inflammatory nature. Fontaine and Herrmann, who also had an opportunity of examining both porotic and normal bone from different limbs, failed to prove any evidence of an inflammatory lesion. It may be said, therefore, that the condition of acute bone atrophy has been proven to be not, as Sudeck first thought it to be, an inflammatory process.

Two hypotheses, only, would appear to be worthy of any consideration, concerning the cause of the condition. One theory assumes that osteoporosis is due to disuse or absence of stimuli due to function. The second hypothesis explains the disease as being the direct result of the trauma and that the

TABLE II
Analysis of Author's Cases

Case	Name	Part	Year	Age	Sex	Time after Injury	Time after Injury	Treatment	Result at		Nature of Injury
						Diagnosis Made	Last Seen		Last Examination		
I	C O	Foot	1926	34	M	2 mos	11 mos	Walking plaster	Recovery	Non cooperative	External rotation fracture ankle, Grade I
II	V I	Foot	1927	21	M	2 mos	6 mos	Hot baths	Recovery	Cooperative	Subastragaloid dislocation Fracture astragalus
III	M A	Foot	1927	40	M	5 mos	17 mos	Walking plaster	Recovery		Distal fracture fibula, Grade I
IV	P L	Foot	1928	46	M	3 mos	3 yrs	Walking plaster	Radical recovery	Non cooperative (Simstros)	Fracture sesamoid
V	C U	Foot	1928	35	M	3 mos	—	Not treated	Lost sight of		Fracture sesamoid
VI	I O	Foot	1930	41	M	3 mos	6 mos	Walking plaster	Returned to Dupuytren	Recovery incomplete but favorable	Fracture first metatarsal
VII	D E	Foot	1931	42	M	5 mos	12 mos	Walking plaster	Recovery	Very cooperative	Chip fracture of cuneiforms Chip fracture first metatarsal
VIII	L A	Hand	1931	35	F	6 wks	—	Plaster-of-Paris	Not seen again		Colles fracture
IX	B I	Hand	1931	49	F	5 wks	20 mos	Local manipulation	Recovery	radiological, clinical	Contusion of hand fracture
X	M G	Hand	1932	51	F	5 wks	6 mos	Digital gymnastics, active exercise	Recovery	radiological, clinical	Colles fracture
XI	W A	Foot	1932	48	M	8 wks	7 mos	Walking plaster	Recovery	radiological, clinical	Distal fracture ankle-joint Grade III
XII	I W	Foot	1932	45	M	3 mos	5 mos	Walking plaster	Much improved		Compound fracture gressor
XIII	I Q	Shoulder	1932	37	M	2 mos	6 mos	Dathermy	Improving		Dislocation shoulder, fracture tuberosity
XIV	W L	Hand	1933	58	M	14 mos	14 mos	Not treated	Recently seen for first time	Radio logical patchy atrophy swelling, pain, stiffness	Contusion hand

bone atrophy is consequent upon reflex action influencing the blood supply. That inactivity does result in a certain type of atrophy of bones, as of other structures, is, of course, evident. At the same time, the type of atrophy under consideration in this contribution shows both clinical and radiological features which are only rarely exhibited. It would appear, therefore, that in addition to disuse *per se* some other factor must be operative.

The experiments of Grey and Carr,¹³ seem to prove that injury to the sensory nerves is not followed by local atrophy, whereas injury to the motor nerves is followed by a certain amount of atrophy. Such atrophy is apparently indirect since it is in proportion to the paralysis produced. Local venous congestion causes no recognizable effects in the bone structure, local anæmia, unless this be extreme, is likewise followed by no bone atrophy. Atrophy, due to inactivity, may become noticeable within four or five days after immobilization in rabbits.

Many experiments, more especially those of Brandes¹⁴ (1913), Grey and Carr¹³ (1915), and Allison and Brooks¹⁵ (1921), have been carried out on animals in an attempt to reproduce the condition of acute osteoporosis found in man. These experiments have shown that atrophy, as the result of disuse or inactivity, may become noticeable within four or five days. In none of these experiments, however, would it appear that the specific condition, which is the basis of this contribution, has been brought about. The explanation for atrophy due to inactivity, given by Grey and Carr, is perhaps a compromise upon the two main hypotheses. They express the opinion that the atrophy, such as they obtained in four or five days after immobilization in rabbits, may be due to decrease or absence of the functional stimuli necessary to the normal nutrition of bone.

Possibly the most important direct evidence obtained by Allison and Brooks, and Grey and Carr, is that neither local venous congestion nor local anæmia is followed by bone atrophy.

Fontaine and Herrmann suggest that "the fact that osteoporosis is more frequent after trauma to the polyarticular regions, such as the ankle or the wrist, is suggestive evidence that stimulation of the numerous articular and peri-articular nerves brings about the vasomotor changes that are ultimately responsible for the production of the osteoporosis." Fontaine and Herrmann's contribution, as well as other articles from Professor Leriche's clinic, have stressed the local hypervascularization as shown clinically by the increased local temperature and the increase of the oscillometric index, in the early stages of osteoporosis. Leriche and Policard, as well as Grieg,⁸ have shown that hyperæmia is a necessary factor for the absorption of bone. Fontaine and Herrmann are of the opinion that true osteoporosis (acute bone atrophy) is the direct result of the hyperæmia produced by vasomotor changes that result from reflexes that originate in the traumatized area.

Although definite experimental proof has not been forthcoming, it would appear that acute bone atrophy occurs as the result of nerve stimuli being transmitted through the sensory nerves from the neighborhood of the

traumatized tissues through the spinal ganglia and that in consequence stasis and accumulation of blood takes place in the periphery of the affected limb. In other words, acute bone atrophy is a phenomenon brought about by vascular changes through reflex channels, or as formulated by Noble and Hauser, this theory explains acute bone atrophy as being reflex trophoneurotic in origin, a disturbance in the metabolism of the bones being produced so that the bone substance is broken down more rapidly than it can be reconstructed.

If the condition of acute bone atrophy, as seen in man, be in fact due to reflex arc stimulation, in consequence of pain initiated at the site of injury, failure to reproduce the same condition in laboratory animals may well be due to the presence of a more primitive nervous system in such animals.

Treatment—That the process of bone atrophy is reversible is, I believe, proven by the results of treatment. At the same time, recovery from the condition may be extremely slow and the patience of surgeon, patient and responsible insurance company, or Workmen's Commission, is likely to be strained. The period required for clinical, if not radiological, cure is likely to be from six months to a considerably longer time.

The author is of the opinion that freedom (with one exception, V T,¹⁶ Case II) from the development of the condition among our own cases, during the past twelve years, has been due in large measure, particularly in the case of the lower extremities, to the fact that unpadded plaster-of-Paris bandage envelopes, with consequent protected weight-bearing, has been employed¹⁷ as a routine in fractures of the foot, ankle-joint and leg. In the case of the wrist fractures the employment of snugly fitting plaster bandages, with early function, protects, we believe, from the syndrome responsible for acute bone atrophy.

Treatment in the case of the lower extremity necessitates confinement of the patient to bed for a period of three or more days, with the limb elevated, in order that all interstitial œdema may be gotten rid of. A silk stocking* is then placed on the limb and a plaster-of-Paris bandage applied from the toes to the knee, in the case of foot and ankle-joint lesions. This bandage is made to cover the fourth and fifth toes, and is accurately molded to the contours of the limb, more especially to the expanded upper portion of the tibia and to the lower border of the patella. Special attention must be paid to reinforcing the plaster in the neighborhood of the heel and ankle-joint. When the plaster is dry, the saddler's felt heel, one inch in thickness, previously described by the author,¹⁷ is fixed to the heel of the plaster by means of adhesive strapping.

When such an apparatus has been applied, it is possible for the patient to walk on the limb without the use of crutches or a stick, and with a minimum amount of discomfort. As a rule, in cases of acute bone atrophy, considerable effort is required to induce the patient to cooperate, since they are characteristically extremely fearful. At the same time I believe that the

* An adequate supply of stockings is always available, without cost, from the waste baskets of the Nurses' Home.

length of time required for recovery from the condition will be in inverse ratio to the amount of walking carried out in the interval

In the case of the upper extremity, either fixation in an unpadded plaster, or better, I believe, the employment of diathermy with careful instructions in the use of active exercises which must not cause pain, may be counted upon to bring about cure of the condition

Noble and Hauser believe that the tendency is for acute bone atrophy to run its course, and that the results of efficient treatment are practically always satisfactory. As they point out, the convalescent period may take many months—even years. They recommend heat to the point of tolerance and advise against the use of braces and casts. The author is in wholehearted agreement with their objection to the use of forcible manipulation.

Fontaine and Heilmann state that since 1924 all cases of osteoporosis admitted to the clinic of Professor Leiche have been treated by sympathectomy, either peri-articular or ganglionectomy. They express the opinion that operations upon the sympathetic nervous system offer a rational and effective treatment for this disease entity and that early treatment in this fashion results in a rapid improvement and the prevention of undesirable sequelæ. These authors point out that it is difficult to explain the mechanism by which this improvement is brought about, since it would appear that the operation of sympathectomy should be contra-indicated in a disease which is caused by hypervascularity of the extremity. They state, however, that the clinical fact remains that improvement can be obtained equally well in cases of osteoporosis with vasodilation, as in those with vasoconstriction as the dominant clinical sign. Since there would appear to be no doubt as to the efficacy of interference with the sympathetic nerve supply to the affected part and since such usefulness is not explained by the effect, of such operations, upon the blood-vessels may it not be that such favorable results are due to destruction of the sympathetic innervation of the tissues *per se*?

The author is of the opinion that such a radical procedure as sympathectomy can only be justified in but a small proportion of cases since as a rule, at least, clinical cure can be obtained by conservative measures, especially if certain contra-indicated procedures are avoided, more especially, painful manipulation with or without the employment of anæsthesia. In the author's group of fourteen cases, in two complete functional recovery occurred, in four others the results were good. In four cases the final result is not known, of these a favorable result was looked for in two while in the remaining two a poor result seems inevitable. Three cases, still under treatment, are progressing favorably and comparatively quickly. One case has been but recently seen for the first time.

The following case histories are reported in some detail since they each demonstrate certain characteristic features regarding the history, clinical phenomena, radiological appearance and progress of the condition of acute bone atrophy.

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CASE III—M. A., aged forty, longshoreman. This man was injured November 2, 1926, when he was knocked over by a board. He is said to have fractured the left

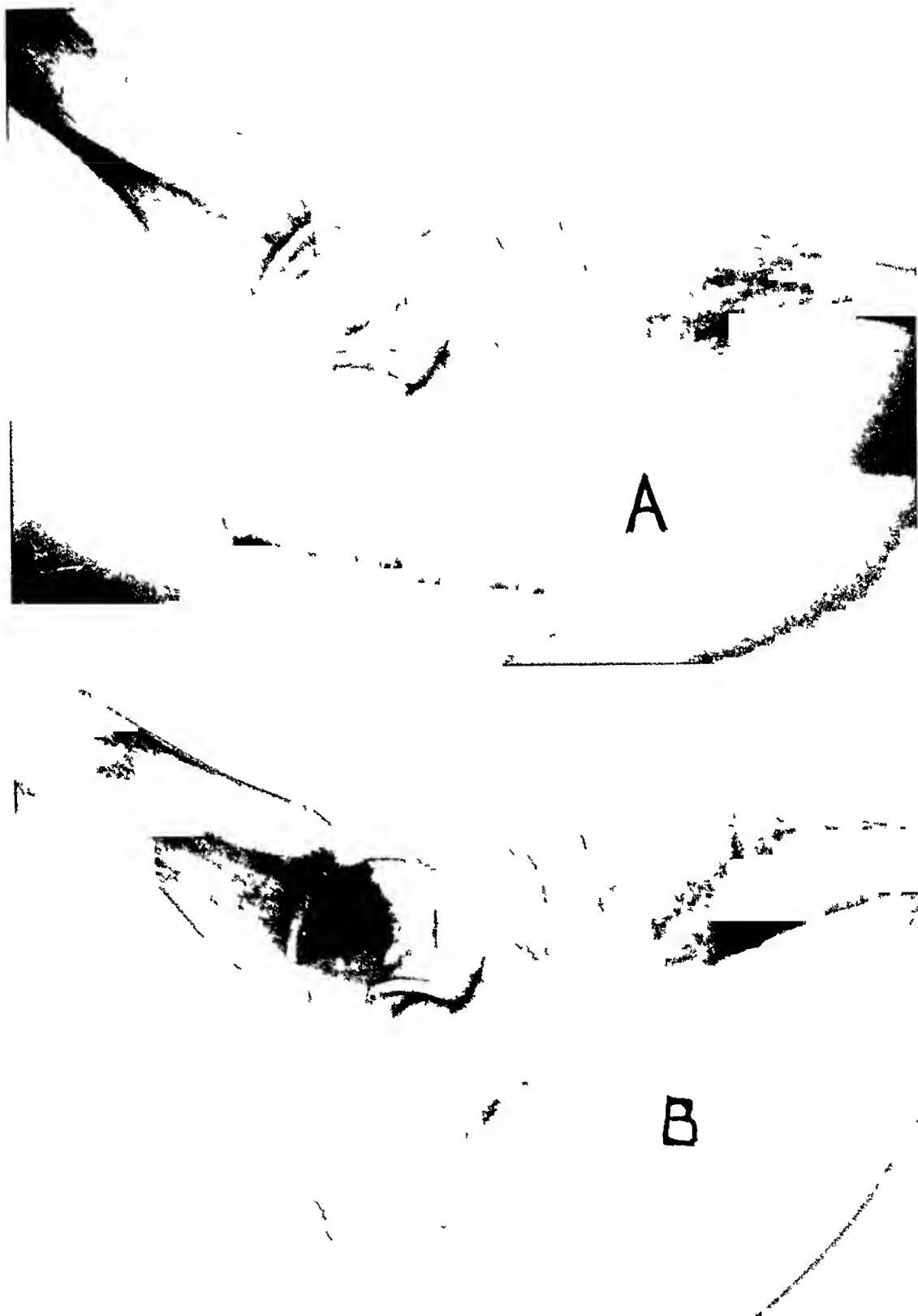


FIG. 3.—(Case III.) (M. A.) Roentgenograms (A) April 5, 1927, five months following fracture fibula, shows moderate acute bone atrophy. (B) January 4, 1928, shows marked evidence of recalcification.

fibula about the junction of the middle and lower thirds, although subsequent X-ray examination did not establish this fact. The affected leg was placed in a molded incomm-

plete plaster splint a few days after injury. Since the condition of his leg following removal of plaster was most unsatisfactory, I was asked to see him during April, 1927. At this time the whole of the leg and foot were moderately to markedly swollen and extremely tender. The patient complained of the slightest pressure at any point, and attempts to move the joints of the foot were accompanied by so much pain that it was impossible to properly examine the limb. X-ray examination made April 8 (Fig 3)

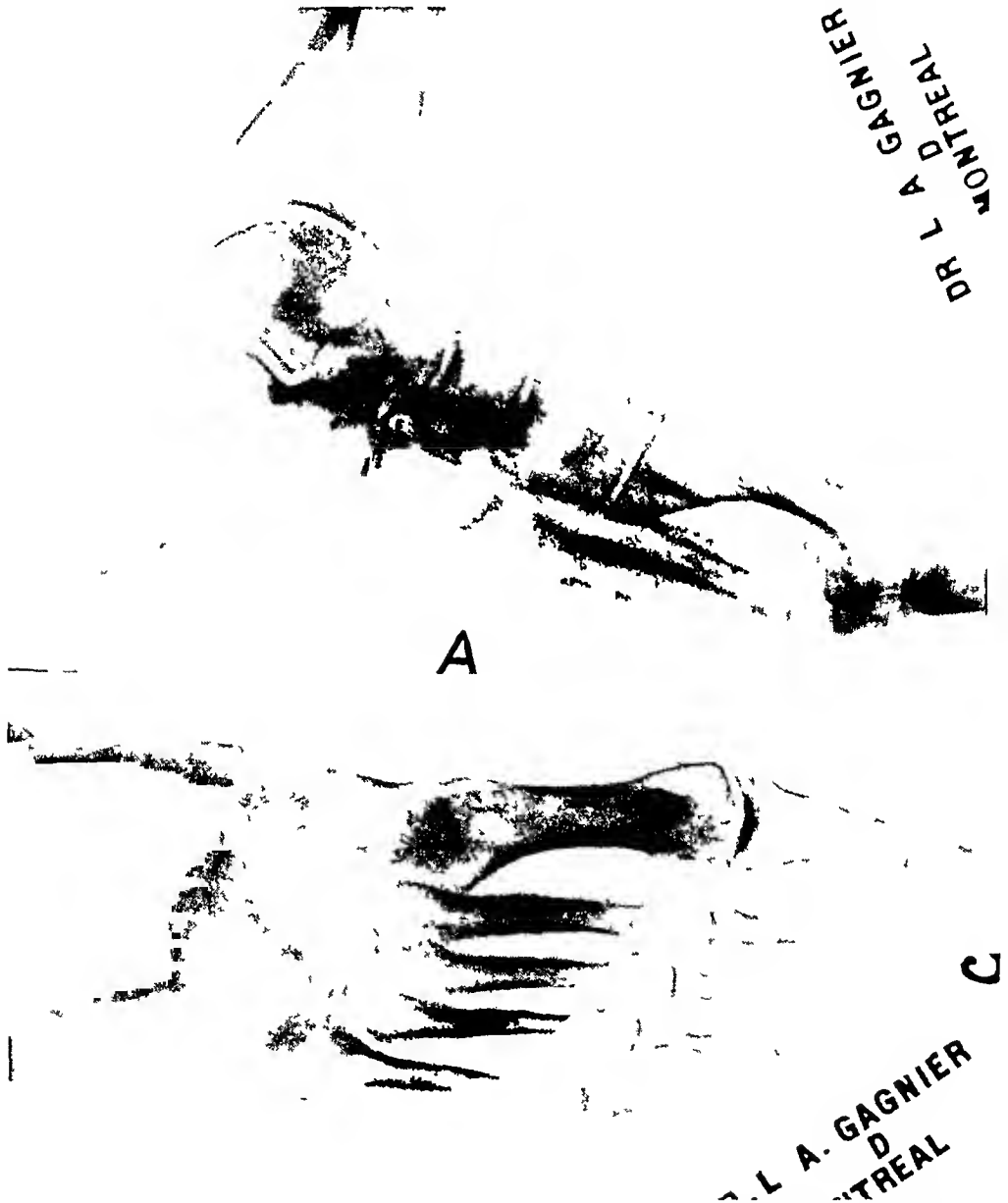


FIG 4—(Case VII) (DE). Röntgenograms (A) and (C). Right foot showing atrophy eight months after injury. clinical improvement already noted.

showed marked patchy atrophy of all the bones of the foot and lower third of both tibia and fibula.

During the month of May the limb was seen by one of the most prominent surgeons in Montreal, who advised amputation of the limb on account of swelling and pain and, more especially, the atrophic condition of the bones as shown by X-ray.

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In January, 1928, although no special treatment other than hot bathing had been employed with a view to correcting the bone atrophy, the condition of the patient's limb had improved much. Swelling had largely subsided, tenderness was much less marked and X-ray examination showed the bones to be returning to a more or less normal appearance. From this time return of function progressed somewhat rapidly so that by the time navigation opened in the spring of 1928 the man was ready to return to work. At the time of his return to work toward the end of April, function of his limb was practically normal.

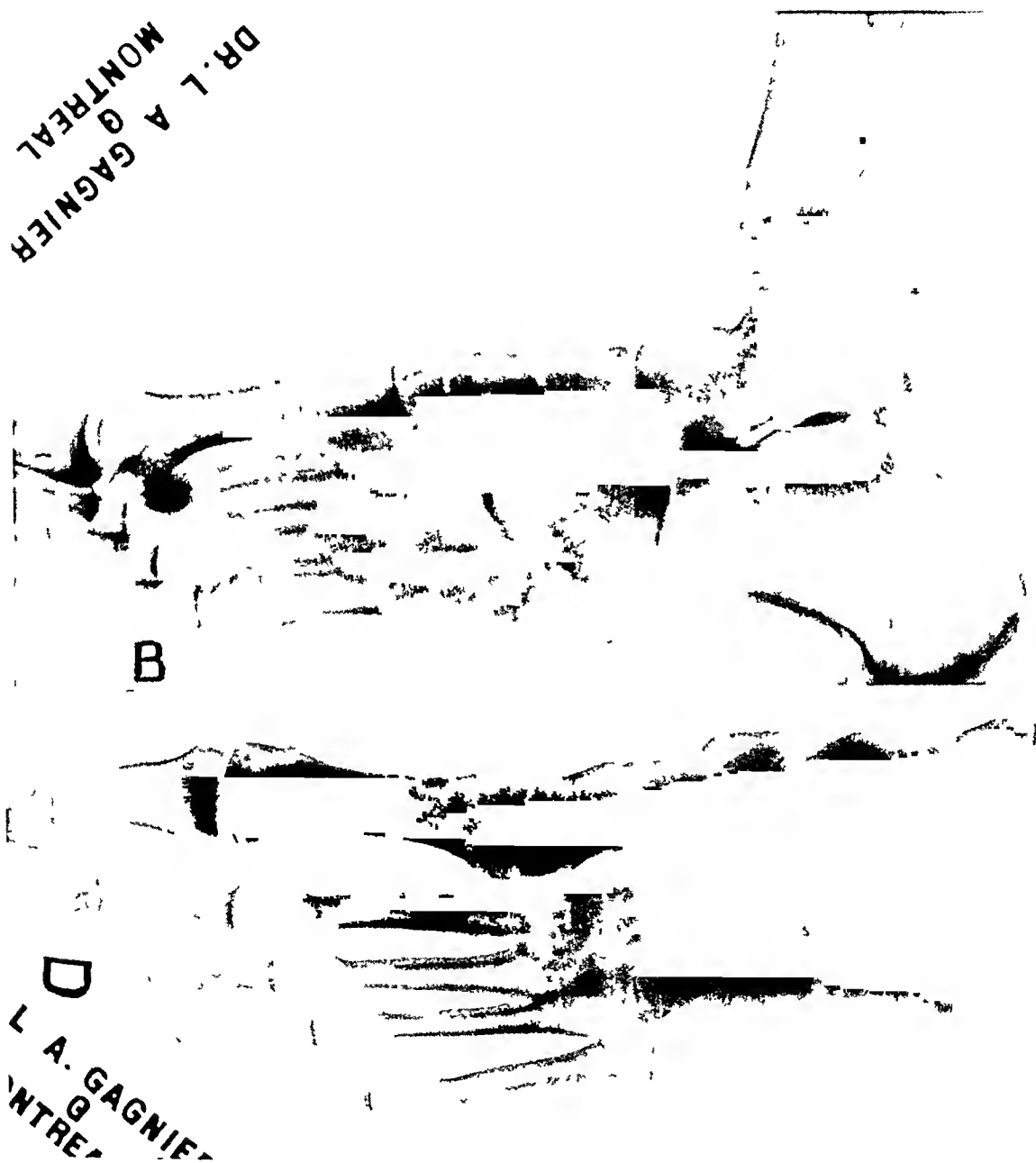


FIG 5—(Case VII) (D E) Röntgenograms (B and D) Normal foot for comparison with Fig 4

CASE VII—D E, forty-two years. Injury April 18, 1931. On April 25, Doctor Gagnier examined this man and reported a small fracture of the os calcis, also a fracture of the first metatarsal with very slight displacement.

On September 26, 1931, I first saw him at my clinic at the Montreal General Hospital, at which time he complained of swelling of the right leg and foot and of extreme pain. When the man stood erect upon the foot, the most extreme grade of pronation occurred, accompanied by subluxation of the subastragaloid joints, and, although he was

able to walk a few steps, he did so only with the greatest difficulty. At this time X-ray examination was made at the Montreal General Hospital and showed no evidence of fracture, but did show a definite condition of acute bone atrophy (Sudeck's atrophy). A walking plaster was applied, after œdema of the limb had been induced to subside by means of posture.

He was next seen by me, through the kindness of Dr I Cote, December 17, 1931, with the note that the plaster-of-Paris had been removed November 6. He stated to me at that time, that at the time of removal of the plaster, the limb was free from swelling and looked normal, although he was not able to carry weight properly. At the time of my examination, December 17, he was walking with the help of a cane, with the foot held in a proper position and without any tendency toward pronation. Swelling was present to a marked degree and the whole foot and ankle-joint were tender and painful when passive movement was carried out. It was recommended, at this time, that a walking plaster-of-Paris cast be re-applied.

He was last seen by me April 19, 1932, at which time his general condition was excellent and he was able to walk comparatively long distances with the shoe on the affected foot tilted one-quarter of an inch. Both lower extremities, at this time, were alike in appearance. There was no swelling. Movements of both ankle-joints were normal, although there was slight spasm of the right foot. Although it had been previously easy for me to force the right foot into a marked pronation deformity with evident subluxation of the subastragaloid joints, I was on this date unable to carry out this manœuvre. X-ray examination made April 12, 1932, showed that recalcification of the bones of the foot had largely taken place.

At this time, April, 1932, I expressed the opinion that the man would be able to return to work, although for a time such work would necessarily have to be of somewhat protected character. The chief permanent disability, in my opinion, in this case, was that due to the laxity of the subastragaloid ligaments.

The most interesting feature of this case, in the author's opinion, was the development of the subastragaloid laxity of ligaments, and the subsequent recovery of this condition under protected weight-bearing.

CASE IX—Mrs B I, forty-nine years. This patient was injured August 13, 1931, as the result of a motor accident. She suffered from concussion, a wound in the neighborhood of the left knee and a severe contusion of the left hand. She was first seen by me October 1, 1931, at which time she made a specific complaint regarding the left hand and wrist, indicating a total loss of function of this member. The palm of the hand was flat and atrophic, the dorsum of the hand and fingers moderately to markedly swollen. The swelling extended to the lower end of the radius. Rotary movements of the forearm were normal. Movements of the wrist and fingers were extremely painful in all directions, except for the thumb, in which movements were moderately good. X-ray examination, September 18, showed patchy atrophy of many of the bones. There was no evidence of fracture of the bones of the forearm, wrist or hand.

She was next seen by me November 20, 1931, at which time, although some improvement in the condition of the hand was exhibited, this member was still practically useless. In the interval hot fomentations had been employed as the chief form of treatment. X-ray examination, which had been made October 26, showed atrophy of the bones of the carpus and hand, although the patchy character noted September 18 was no longer evident.

Examination made January 23, 1933, shows that, although some improvement has taken place in the function of the hand, the latter is still seriously disabled. Rotary movements of the forearm and movements of the wrist-joint are normal. Movements of the thumb are normal and movements of all metacarpalphalangeal joints are approximately normal. All four fingers are slightly swollen—the patient states that at times

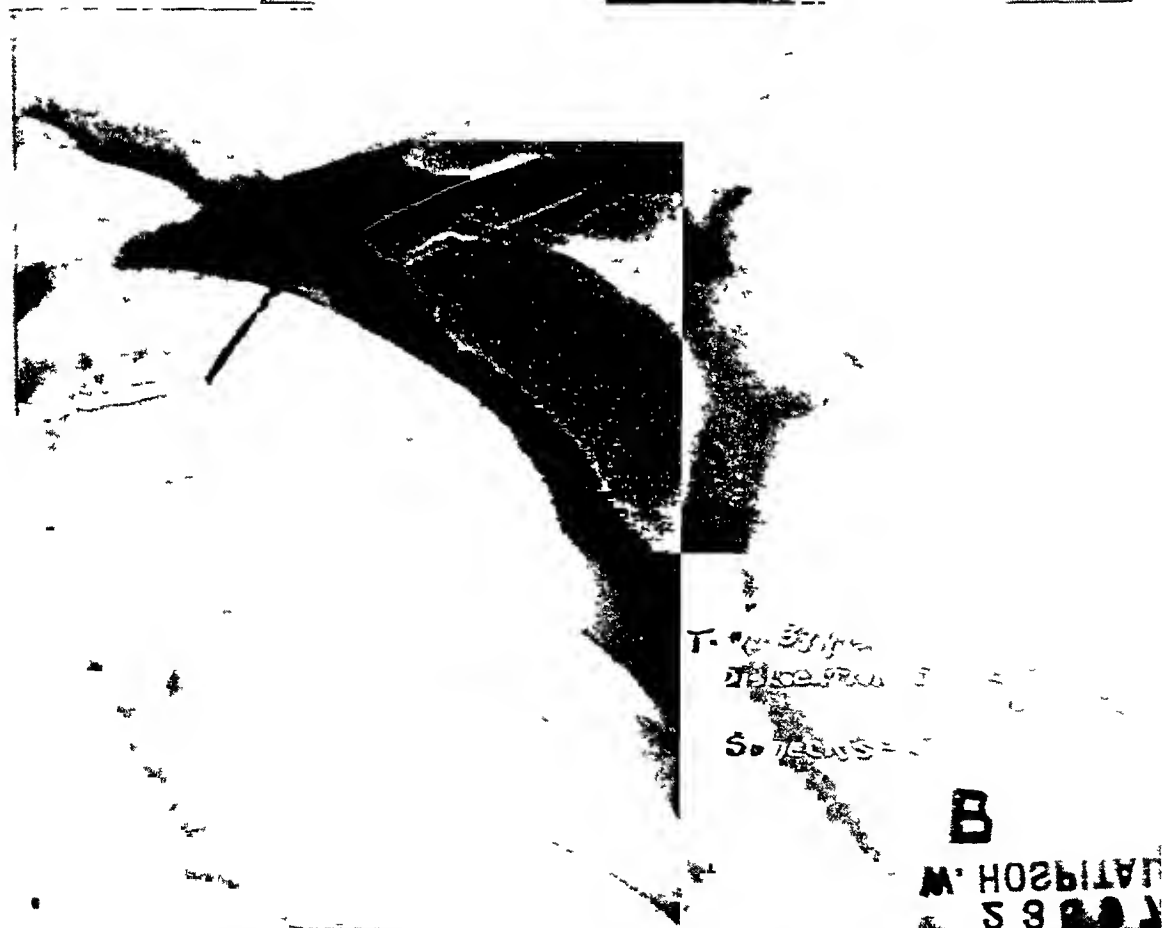


FIG. 6.—(Case XII.) (T Q) Röntgenograms both shoulders. (A) Normal shoulder (B) Atrophic shoulder. Seven weeks after dislocation reduced the day of injury.

they are more swollen—and are very stiff The distal interphalangeal joints are all incompletely fixed in slight flexion

X-ray examination made January 23, 1933, shows that the bones have almost regained their calcareous content, although in the interval practically no activity of the hand has been employed The only important point of interest in connection with the case was that in September, 1932, manipulation under an anæsthetic was employed

The last case to be detailed is, perhaps, the most interesting of the series The history of repeated insult during treatment, the typical clinical and radiological appearance and the satisfactory result of conservative treatment—diathermy and graduated function—are all, I believe, instructive

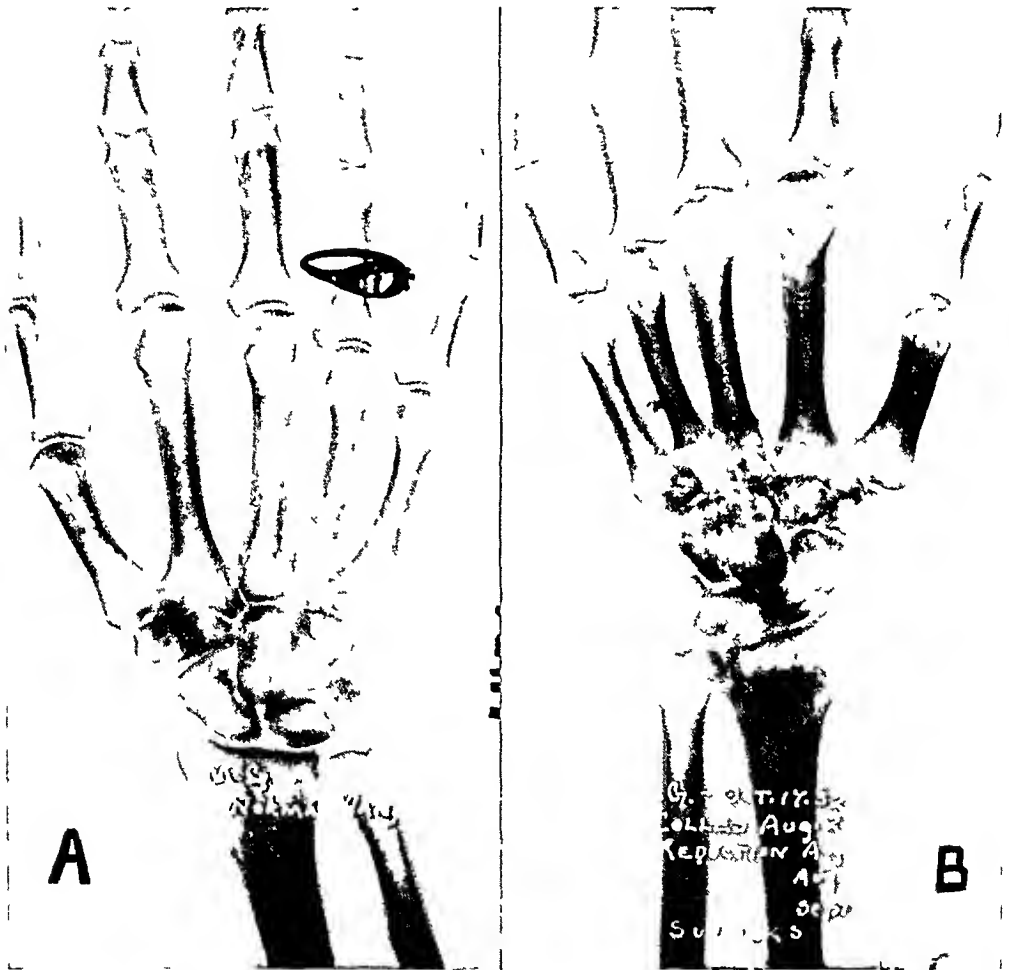


FIG 7—(Case X) (M G) Röntgenograms both hands (A) Normal right hand (B) Left hand, seven weeks after Colles fracture shows marked osteoporosis of typical patchy character

CASE X—Miss M G, fifty-one years This lady fell while on shipboard, suffering a Colles fracture of the left wrist An immediate attempt at reduction by the ship's surgeon was carried out and the forearm fixed in splints Three days later upon arriving at port, reduction was again attempted under local anæsthesia and plaster-of-Paris, in the form of a molded posterior splint, applied Two weeks after injury a further attempt at reduction, under general anæsthesia, was carried out and a heavily padded circular plaster bandage applied

The patient was first seen by me September 15, 1932, eight days after the third attempt at reduction, at which time the fingers and hand were swollen and all move-

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ments, both active and passive, of fingers and wrist were very painful Plaster-of-Paris was re-applied without padding The condition, however, became increasingly more painful and the limb more useless In this respect she volunteered the information that prior to the third attempt at reduction, approximately fifteen days following injury, movements of the fingers had been free and the hand relatively painless

X-ray examination made October 17, 1932, showed well-marked patchy bone atrophy to be present This atrophy involved the lower end of the radius and ulna and all the carpal bones, both extremities of the metacarpal bones, and to a lesser extent, the phalanges The joint contours were unusually distinctly shown Union at the site of fracture of the radius appeared to have progressed satisfactorily and with but little displacement

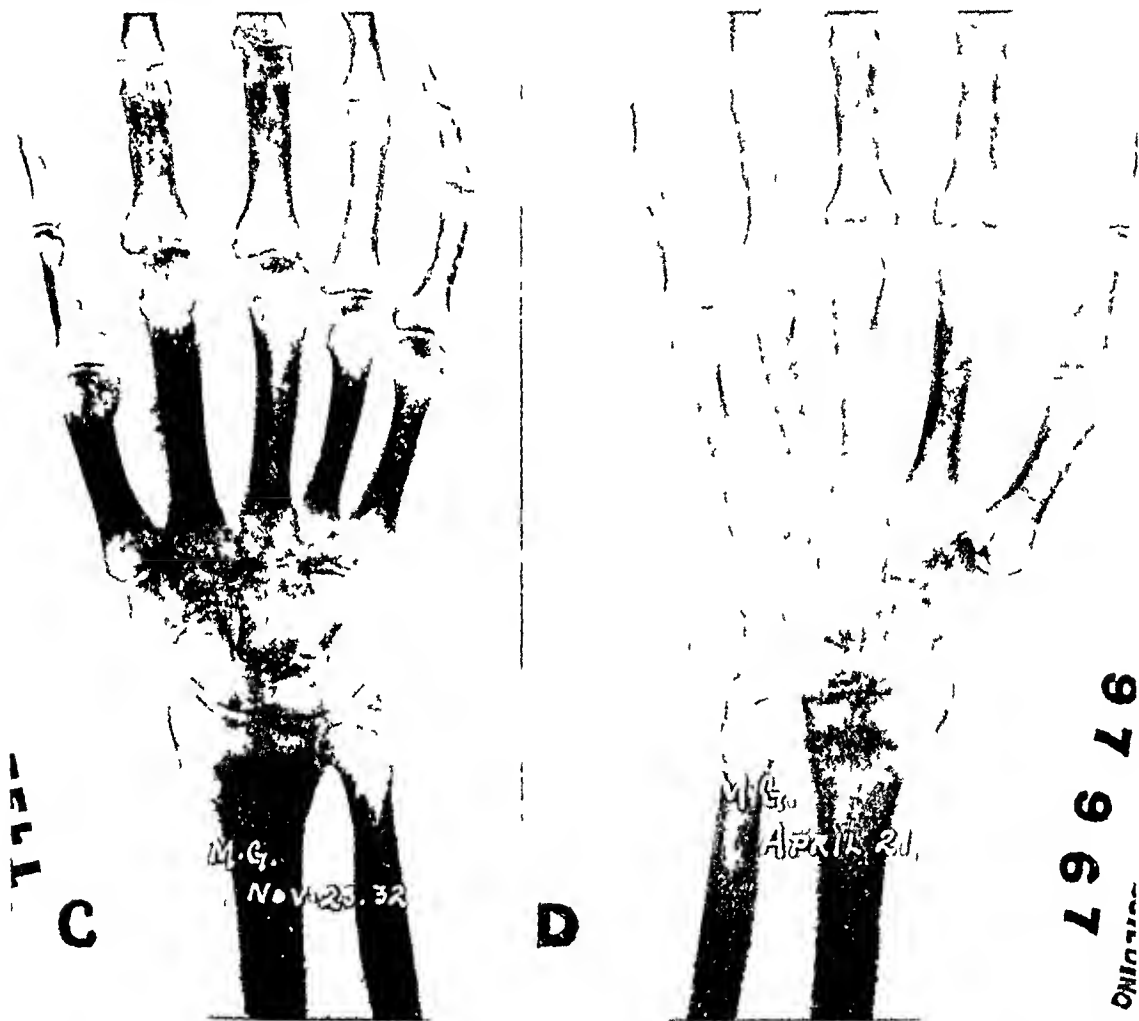


FIG 8—(Case X) (M G) Röntgenograms of left hand (C) Twelve weeks after injury Diathermy five weeks shows commencing improvement (D) Five months after C Diathermy, clinical cure, radiologically marked recalcification

Plaster-of-Paris was removed October 17 and the patient instructed to avoid carrying out any movements which caused even the slightest amount of pain Diathermy was instituted three times weekly and active movements, under instructions, short of pain

Progress has been slow but continuous By February 15 swelling had largely subsided and movements were all at least half normal X-ray appearance of the bones had altered so that patchy appearance was no longer present and evidence of recalcification of the bones was seen in picture made January 17, 1933

This case demonstrates, among other things, the fact that the development of acute bone atrophy does not appear to influence the time required for the healing of fractures

SUMMARY—Although a certain grade of bone atrophy occurs habitually when extremities are put at rest, such atrophy is of trivial importance. In a very small percentage of cases acute marked osteoporosis occurs within a short time following injury.

Acute bone atrophy following injury was first described by Sudeck in 1900. The condition exhibits typical clinical and radiological appearances.

Pain is a predominant factor together with extreme loss of function. Swelling and evident atrophy of the skin and subcutaneous tissue are characteristically present.

The condition follows, as a rule, more or less trivial injuries, particularly in the neighborhood of joints, and more especially in the neighborhood of ankle- and wrist-joints.

Pathological studies prove a uniform loss of bony substance and not merely a depletion of mineral salts.

The explanation for the condition would appear to be that through a stimulus of the reflex arc with consequent local hyperæmia bone absorption is brought about.

Although it would appear that the phenomena responsible for the condition are reversible, cure may require a very long period of time. In the case of the lower extremities protected weight-bearing is the most important factor in treatment. Diathermy is apparently useful and at Leriche's Clinic in Strasbourg ganglionectomy has apparently proved its usefulness.

Two tables are published. One analyzes twenty-one cases reported in detail by Fontaine and Herrmann. The other analyzes fourteen cases studied by the author. Four of the author's cases are reported in some detail.

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DISLOCATION OF THE CERVICAL VERTEBRÆ

REPORT OF A CASE OF COMPLETE FORWARD DISLOCATION OF THE SIXTH
CERVICAL VERTEBRA WITH REDUCTION BY FORCIBLE TRACTION
AND FULL RECOVERY

BY DAVID WARSHAW, M D

OF NEW YORK, N Y

THE following case of complete forward dislocation, which has recently come under my own observation, is one in which full reduction of the dislocation was secured by forcible traction and counter-traction under anesthesia without subsequent immobilization

CASE HISTORY—A man, aged thirty, was admitted to the Albany Hospital in the evening of March 23, 1932. When first seen by me he was standing in a peculiar ape-like posture, with head bent forward, making it necessary for him to look upward as though peering over the top of eye-glasses. The hands and arms hung forward, and the body was slightly flexed. He stated that while riding in an automobile that afternoon he had been thrown forward against the right front of the car when it skidded off the road into a telegraph pole (5 P M). Neither his companion, who was driving the car, nor he seemed at the time to be seriously hurt, and except for severe pain in the back of the neck, inability to turn his head comfortably and tingling sensations in his finger-tips, he had little to complain of. He had been brought to Albany in another car, a trip of twenty miles from the scene of the accident. The ride had caused so much pain at the base of his neck that he had consumed almost an entire pint of whiskey in his attempts to relieve it.

The patient was a well-built, rather heavy young man, weighing 210 pounds. General examination was negative. In addition to the abnormal posture, one could note a definite depression at the site of the sixth cervical vertebra deep enough to insert the tip of the finger. Active and passive movements of the head and neck caused marked pain. There was pronounced tenderness at the base of the neck posteriorly. Abduction of the arms was limited to the horizontal. Beyond that point pain resulted. The reflexes of the arms were apparently normal. There were paresthesias of both hands, and diminution of tactile sensation. The hand grips were weak. Aside from these findings, all was negative.

The roentgen findings in a lateral film showed the presence of a complete dislocation of the articular facets of the sixth cervical vertebra on the seventh. The only indication of a dislocation in the antero-posterior exposure was a suspicious widening of the gap between the spinous processes of the sixth and seventh cervical vertebræ. There was no X-ray evidence of fracture of the dorsal region of the spine.

The patient was immediately put to bed and traction applied by means of a jury-mast and weights. The head of the bed was raised and ten pounds of weight applied over the top of the bedstead. This was gradually increased to twenty pounds, but the patient rebelled so strenuously that a compromise was necessary, the patient being given an hour's rest alternating with an hour of traction.

The next morning, after a night rendered sleepless by pain, he refused this method of treatment absolutely, insisting that he felt as though his lower jaw were being pushed through his head. When examination showed that nothing had been gained by these measures, the patient was offered the alternative of traction under ether, after the dangers of this course had been fully explained to him. He readily accepted, and on the fol-

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lowing morning (March 25) an attempt at reduction was accordingly made under colonic anæsthesia. This form of anæsthesia, however, did not produce sufficient relaxation, nor did the bed afford sufficient leverage for traction. The patient was therefore placed on the X-ray table with his head beyond the end of the table, and after an adequate deep inhalation anæsthesia, strong, forceful and gradually increasing traction was applied. The surgeon sat on a stool and pulled on the traction straps with his feet braced against the patient's shoulders, while at the same time two assistants employed counter-traction.

After a few minutes of this slow, steady pull, the patient's head was rotated strongly to the left and then relaxed, as a grinding snap was heard. Fluoroscopic examination



FIG 1

FIG 2

FIG 1—Appearance of patient with complete forward dislocation of sixth cervical vertebra

FIG 2—Appearance of patient after reduction of cervical dislocation. He states that this was his normal posture before the injury.

showed partial reduction. Similar stretching and rotation to the right was then employed, until a similar snap and grating were felt. The X-ray picture at this time showed complete reduction. No form of immobilization was employed after treatment.

On recovering from anæsthesia the patient was examined for signs of spinal cord injury, with negative findings. He complained of some pain in his neck, but was able to rotate the head and neck without difficulty. The next day he could accomplish these motions with only slight discomfort and was allowed out of bed. After a few more days of observation, during which practically all pain and tenderness disappeared, he was discharged to his home on the twelfth day of hospitalization. He has been perfectly well to date. Figure 2 shows the patient after reduction of the dislocation.

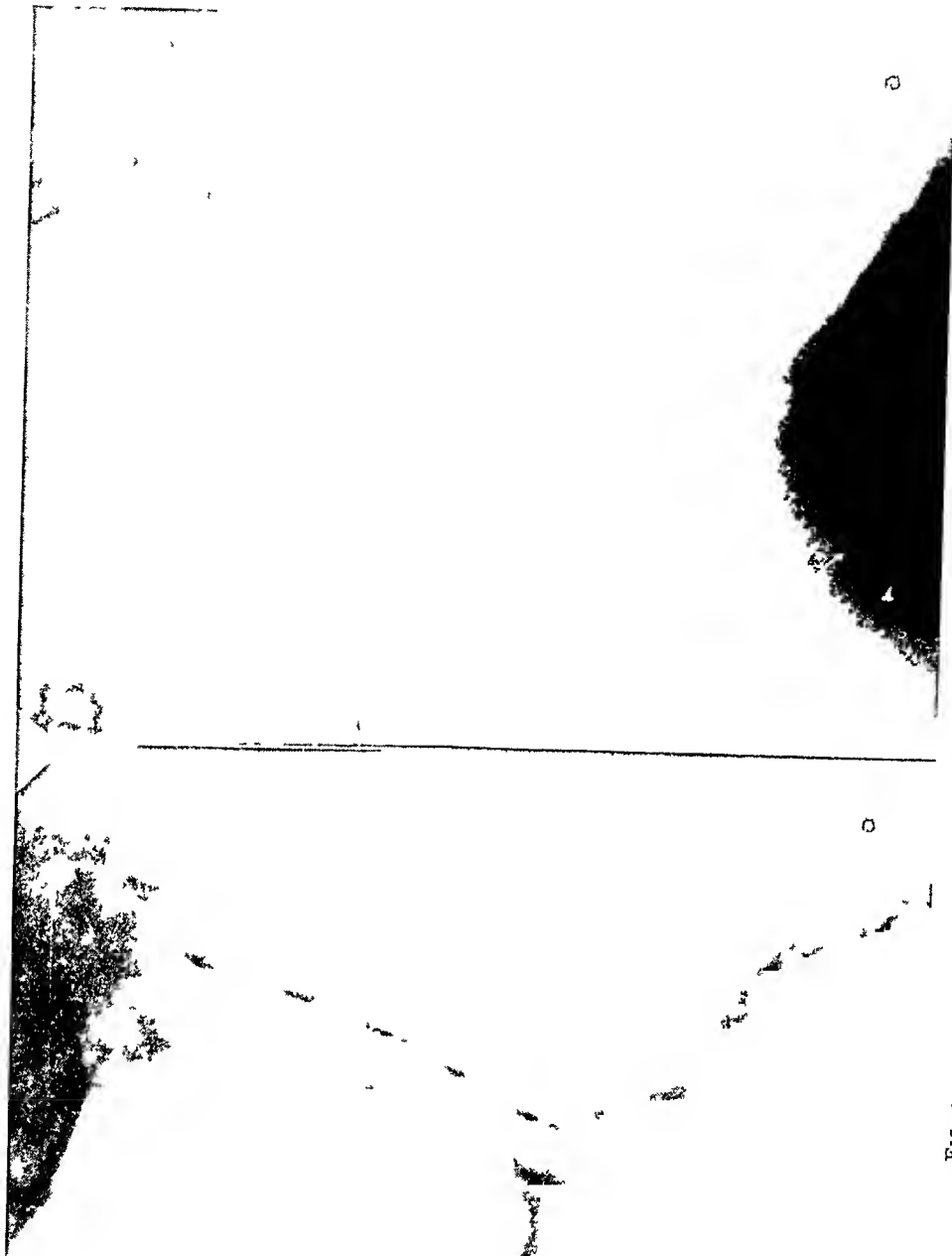


Fig 3

Fig 3—Lateral exposure. This clearly shows the presence of complete dislocation of the sixth cervical vertebra on the seventh. Note the projection backward and upward into the spinal canal of the posterior superior border of the sixth vertebra. Note also similar displacement of the facets of the seventh cervical behind those of the sixth. The procedure necessary to reduce such displacement becomes evident. (See text.)

Fig 4

Fig 4—Lateral exposure after forcible traction under fluoroscopic control shows complete reduction of forward dislocation of sixth cervical vertebra.

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DISCUSSION —The case is cited as representative of a hopeful type of cervical vertebra traumatism in which the cord remains uninjured, only a few peripheral nerves being involved, as expressed in the temporary paræsthesias of both arms. The sixth cervical vertebra had slipped forward on the seventh on both sides, where it hung helpless, making effective movements of the head almost impossible. It was a case of complete forward dislocation, which yielded readily to reposition by traction under general anæsthesia. The fact that the patient made a permanent recovery without any form of immobilization is a matter of some interest, in view of the prevailing view that hyperextension in some form of apparatus or plaster is necessary over a long period in cases of this kind.

In diagnosing dislocations of the cervical vertebræ, it is important that the physical examination be as complete and thorough as possible, to avoid unpleasant surprises at a later time. The diagnosis may be very easy or extremely difficult. Account must be taken of the history, the nature of the trauma, and the appearance of the patient, who frequently, as in the above case, has his head strongly bent forward and is able to move it only with difficulty. This appearance immediately suggests the presence of dislocation or fracture. In McKenna's¹¹ case the essential feature was left-sided torticollis. Binnie's¹⁶ case presented no notable deformity of the spine, but the patient was suffering acutely with cervical pain. The presence of contusions and distortions, of torticollis and lacerations, with pain upon attempting to move the neck, should always arouse suspicion of a dislocation or fracture.

The court of final appeal, however, must always be the X-ray. In no case must the negative findings of a simple antero-posterior view be trusted, for in the presence of a dislocation it is the lateral view that will show a marked deformity in the contour of the vertebral column. Langworthy,⁴ in fact, who has performed the Walton operation successfully in thirty cases, regards only the lateral view as having any value. He not only makes roentgenograms before and after reduction, but if, as frequently happens, several attempts are necessary before reduction is accomplished, he makes a fluoroscopic examination after each one. He points out, however, that unilateral cases cannot be shown in roentgenograms, these being largely rotations, with the crooked position of the head and the tilting of the chin as the chief symptoms, associated with limited lateral bending of the head. Mackinnon² emphasizes the importance, in addition, of making a vertical shift, which has the advantage of showing one or two vertebral bodies clearly above or clearly below the one under suspicion, so that an effective comparison can be made with a view to establishing the site of dislocation.

When a differential diagnosis has to be made between dislocation and fracture, errors are possible even in spite of good X-ray pictures, says Laesecke.⁷ In the cervical portion of the vertebral column, especially as a result of the protrusion of the larynx and trachea, and even more because of the many overlappings of articular and transverse processes, with their

many articular facets and small prominences, the rontgen picture offers much more possibility of false interpretation than in lower portions of the spinal column

If cord injuries are present, there will be a paralysis of the parts whose nerve supply is compressed at the level of the cord corresponding to the dislocated vertebra

Treatment and Results—*Stemmann*⁷ in 1906 first reported the diagnosis of dislocation of a cervical vertebra by means of X-rays, thereby introducing a new era in the treatment of these injuries and bringing possibilities of recovery to a class of cases that had hitherto been regarded as hopeless. For, as Sommer¹ points out, it was the uncertainty of diagnosis that made great surgeons like Nelaton, Dupuytren, Richet, Desault, Porta, Bayer and Blasius refrain from reposition in order not to make bad matters worse. In the middle of the nineteenth century certain surgeons did, indeed, begin to urge active operation, but it was not until after rontgen diagnosis had become an actuality that modern surgical methods could be applied to these injuries without fear of fatal consequences.

Today the Walton¹⁸ method of reposition and the rather similar Wagner-Stolper¹⁰ procedure employed in Germany are available for every promptly diagnosed cervical vertebra dislocation.

To replace the articular facets that have slid apart, Walton conceived the idea, which he published in 1889, of bending the head first toward the right side to disengage the facets in a left-sided dislocation in order to lift the facet of the dislocated vertebra out of the intervertebral notch of the one beneath it. He then rotated the head to the left, to throw the facet backward and downward, in such a way as to make it fit onto the lower one. For the right side, in a bilateral dislocation, he did the reverse of the same process. To this method of closed reduction he gave the name of "retrolateral flexion with rotation."

In applying the Walton method, Langworthy uses the edge of his hand as a fulcrum on the opposite side of the neck from the lesion, while he bends the head laterally to disengage the facets. Since this part of the procedure requires very great force, he found that the edge of the hand on the opposite side of the neck aids in lifting the displaced facet and prevents a lateral pushing of the entire head and neck toward the shoulder, which would frustrate his efforts. After reposition, he invariably uses a plaster case to maintain the head and neck in hyperextension.

The Wagner-Stolper procedure consists of four movements: (1) a strong pull to bring about extension, (2) a slight backward push upon the dislocated vertebra, (3) a slight backward bending of the same, and (4) fixation in slight hyperextension.

In both procedures, the patient is so placed upon a table that a counter-pull can be made footward upon the shoulders by assistants, while the operator pulls in the opposite direction, his hands, placed laterally upon the head, controlling the vertebral processes with the finger-tips. The loud snap with which the displaced vertebra slips into place is characteristic, and gives assurance to the operator that he has accomplished his purpose.

Slow reduction by a Glisson sling is advocated by Laesecke in many cases. Even where there was high-grade injury to function of the spinal cord, he found that conservative treatment led to far-reaching improvement of the neurological symptoms. Hibbs²⁰ regards fusion of the articulating bones as a necessary procedure, eliminating motion and offering, in his opinion, the only chance for securing relief. The fusion is made to include at least one healthy vertebra above and one below the injured one. He reports that it has been successful in all cases in which it has been used at the New York Orthopedic Hospital.

Blasius³ (1869) in a series of 159 definitely diagnosed dislocations of the cervical spine collected from the literature, found thirty-six favorable and 123 fatal results, or a ratio of one case of complete or partial recovery to 4.5 cases terminating fatally. Of the thirty-six favorable cases, seven had recovered spontaneously without a physician.

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However, in cases of bilateral forward luxation, which are the most common and the most dangerous, he noted a percentage of fatalities amounting to 92.6. He cites Malgaigne²¹ (1806-1865) as having regarded unreduced bilateral dislocations as 100 per cent fatal, and these cases were not uncommon, for in Malgaigne's day surgeons hesitated to reduce, owing to the uncertainty of diagnosis. Blasius also collected thirty-seven unreduced cases in which the time of death is mentioned, as follows: Six within twenty-four hours, fourteen in the next two days, thirteen within three to eight days, and four within ten, twelve, nineteen and seventy days respectively.

Nineteen years after Blasius made his extensive statistical study, Wagner and Stolper¹⁹ (1898) collected 205 cases, including their own, of dislocations of the lowest five cervical vertebræ. In this collection the fatalities numbered 148, and the cases cured or improved fifty-seven, a ratio of 26:1. As regards type of lesion, these were distributed as follows: bilateral forward dislocations 141 (118 dead, twenty-three surviving), rotation dislocations, forty-nine (eighteen dead, thirty-one surviving), backward dislocations fifteen (twelve dead, three surviving). These authors added three more to the list of seven cases recovering spontaneously. They credit Vignonneau²² with having been the first to reduce a bilateral forward luxation.

Walton¹⁸, in 1889, reported five personal cases, two bilateral and three unilateral, in four of which treatment by traction and rotation resulted in partial or complete recovery. In the fifth case, which was a bilateral dislocation of the fourth cervical vertebra, the patient did not come to the hospital until two months after the accident, and reduction accordingly failed, he became helpless for fifteen months, then suddenly, in the bathtub, felt a sensation like an electric shock, as the displaced vertebra slipped spontaneously into place. Recovery was complete, and the patient was able to resume work within a month.

Quetsch⁹ (1914), had eight bilateral cases, which he reduced successfully by the Wagner-Stolper method. In seven of these there were cord injuries, which recovered in the course of time. In five other cases the patients were left permanently with limited motion of the head.

Meyer²³ (1914), reporting a case of complete dislocation in which there was full recovery after reduction by the Wagner-Stolper method, expressed the belief that the spinal cord does not nearly fill the entire cavity of the spinal column, and that it can consequently bear considerable pressure before it becomes compressed, thus accounting for the possibility of such cures.

Of the thirty personal cases which Langworthy⁴ (1930) has successfully reduced by the Walton method, seventeen were bilateral and thirteen unilateral. All the unilateral cases ended in complete recovery. Of the seventeen bilateral cases, twelve recovered, in one of the twelve, there was redislocation ten weeks later, reduction was again done, this time with recovery. In eight of the seventeen cases, there were severe cord injuries and in five of these death occurred after reduction had been accomplished, thus making a mortality of 30 per cent in bilateral cases—in strong contrast to the 92.6 per cent in Blasius' day.

Ploye,¹⁰ who reduced three unilateral dislocations in less than a month, found that kelene local anæsthesia produced such complete relaxation that there was complete muscular resolution, making reduction so easy that the patients returned to work after two days.

Prognosis—Because of the frequency of severe cord injuries, complete dislocations as a rule have an unfavorable prognosis, though less so than formerly. Luxation of the four uppermost vertebræ often paralyzes respiration and is therefore immediately fatal. Baur¹³ has reported a case of this kind, in which all the first four vertebræ were dislocated upon the fifth. The cord function was irremediably compromised and the case terminated fatally on the day following the injury. In asphyxial conditions reposition executed promptly enough may succeed in relieving the respiratory disturbance. Steimann¹⁷ in 1906 collected twenty cases of complete luxation of cervical vertebræ in the

literature, in patients who lived on after their accident. Meyer¹ in 1914 collected thirty-one cases that had survived. Langworthy¹ reports that he has found lesions in the upper and lower cervical vertebræ are equally dangerous.

When cord injuries are present, paralysis may persist for a time, yet clear up later if there has been only simple compression from hæmorrhage. Sommer asserts that the most important disturbances remaining are of a static nature, consisting of motor disturbances and decreased capacity for carrying burdens. While these are less in the cervical than in the dorsal and lumbar vertebræ, they nevertheless cause in elderly persons a strong forward bend of the head, followed by ankylosing spondylarthritis and diminished mobility. Young individuals can compensate the dislocation better by lordosis, because of greater elasticity.

According to Elsberg²¹ there are cases of spinal injury in which the symptoms at first are those of complete transverse spinal lesion, but in which after the expiration of days, weeks or months a considerable or perhaps complete return of power and sensation occurs. He maintains that in cervical and dorsal injuries with transverse cord symptoms an operation should never be performed until distinct and definite signs of returning sensation and reflexes give proof that part of the transverse diameter of the cord is intact. In partial lesions of the cord, however, he regards the problem as entirely different. If the injury has not been severe enough to interfere with all the cord functions, then pressure by dislocated or fractured bone may be contributing to the symptoms, and relief by a wide decompressive laminectomy is certain to be of great benefit.

Taylor²² did a hemilaminectomy in a case of fracture-dislocation between the fifth and sixth cervical vertebræ, relieving the patient of all symptoms but a typical left ulnar paralysis. Another case of Taylor's was completely restored by traction.

Where no cord injuries exist, the dislocation can frequently be reduced, as in the case here reported. The sooner this is done, the better the prognosis. McKenna²¹ regards reduction as difficult after the tenth day, even under an anæsthetic, and holds that in three to six weeks the displaced vertebræ are so fixed that the task is impossible. Bony and fibrous adhesions form, which may sometimes be improved by open operation, as in de Quervain's²⁴ two cases of old dislocations in which he did an autoplasty, using the scapula, with excellent results.

Of all the vertebræ in the entire spine, the six lower cervical exhibit the greatest tendency to undergo dislocation, especially that pure type of luxation which is unaccompanied by simultaneous fracture.

There are very good anatomical reasons why this should be the case. The atlas, as Sommer¹ has pointed out, is held in place by powerful muscular bands. The ribs exert an effective control over the dorsal vertebræ, binding them into a compact column, difficult to interrupt. The lumbar vertebræ are bound together into an almost impregnable piece of masonry, and will fracture before they will dislocate. Any dislocations occurring here as the result of severe blows are practically always associated with fractures.

The six lower cervical vertebræ, on the contrary, are always exposed to the danger of dislocation by the very fact that they are designed to give mobility to the head. Their principal protection is the strong musculature of the neck and shoulders, in the powerful *ligamentum nuchæ*, but this is by no means invincible. Its resistance can be broken down by a blow appropriately directed upon the skull and reflected upon the vertebræ.

"If we remember," says Sommer, "that the cervical vertebræ are so-to-say based upon the dorsal vertebræ belonging to the the back, and that all move-

ments of the head are for the most part accompanied by movements of the cervical vertebræ against the back, so that when violence is inflicted upon the head, these vertebræ bear the brunt of the blow, we can readily see that it is here that dislocations must occur with relative frequency. Then if we add to this the anatomic peculiarities of the cervical vertebræ, the relation of height to breadth, the high intervertebral disks, the oblique position of the joint surfaces, the labile displaceability upon the vertebral disks which serve as cushions to give the vertebræ their ready mobility, but which yet predispose to a separation of the articular facets from one another upon exaggerated motion, it becomes evident that bony restraint and protection are entirely wanting."

A glance over the literature reveals that the fifth cervical vertebra stands first in order of frequency of dislocation, the sixth second, with the fourth and third next in about equal incidence. Mackinnon² in twelve cases, involving twenty-two cervical vertebræ, found one dislocation of the second, three of the third, four of the fourth, seven of the fifth, six of the sixth, and one of the seventh. Blasius³ in a collection of eighty-four cases found the second dislocated eight times, the third thirteen times, the fourth twelve times, the fifth twenty-four times, the sixth twenty times, and the seventh seven times. Langworthy⁴ among seventeen bilateral cases of cervical dislocation had six luxations of the fifth, and three each of the second, fourth and sixth vertebræ. Bobiecker⁵ confirmed the figures of Blasius, while Kocher⁶ gave the chief place to the sixth, reporting two of the fifth, nine of the sixth and two of the seventh. In the last five years Laesecke⁷ has had two dislocations of the sixth upon the seventh, two of the fifth upon the sixth, one of the fourth and fifth together, and one of the third.

According to Feistkorn⁸ the sixth cervical vertebra is especially disposed to dislocation through its small breadth in proportion to height, the peculiar elasticity of its intervertebral cartilage and the obliquity of its articular surface.

Dislocations of the cervical vertebræ are rather more common than was supposed prior to the diagnostic use of the X-rays. From the cases reported there is no reason to believe that they have gained in frequency, as is sometimes asserted in view of the multiplicity of automobile accidents, but only that the roentgen rays have made their detection easier, so that cases that would formerly have remained undiagnosed are now recognized with comparatively little difficulty. Quetsch⁹ stated twenty years ago that serious dislocations had been overlooked by physicians who observed nothing beyond muscle contusion. That these injuries are not altogether rare is proved by the fact that in nine years of private practice Langworthy had thirty cases of which seventeen were bilateral and thirteen unilateral. Laesecke⁷ has reduced nine fractures of the cervical portion of the spine, four of which were accompanied by dislocations. Ployé¹⁰ has recently reported three cases of medio-cervical subluxations observed in a single month in the Maritime Hospital of Cherbourg.

The mechanism of these dislocations appears to be a sudden blow inflicted upon the head at a moment when the neck is partly flexed. Thus Mackinnon² reports three cases due to a fall, alighting on the head, three in which the victim was thrown from an automobile or plow, one from diving into shallow water, others from blows on the head, the sandwiching of an individual between two handcars, and from being run over while in a doubled-up position. It is not uncommon, says this author, for such injuries to result from a very slight trauma. McKenna¹¹ says they may result from any sudden jerk. Sweaney¹² and Baur¹³ have reported cervical dislocations from football injuries. Feistkorn's⁸ case was that of a man who fell with his head bent backward in a wrestling match.

Whatever the cause of the trauma the effect upon the vertebra struck is to make it slide upward on the facet of the one lying beneath it and, catching on top of this, to remain locked in its unnatural position, or it may slip completely over into the intervertebral notch in front of the lower facet. In either case the patient's head is suddenly rendered immovable or nearly so, the loss of function, according to de Quervain,¹⁴ being worse than in fractures. The dislocation may be bilateral (complete) or unilateral (partial), it may be forward or backward, or it may be a torsion dislocation of the atlas, as in Brookes and Ewerhardt's¹⁵ case. Luxation toward the front, according to Feistkorn,⁸ aside from the effect of the direct blow, is due to excessive curvature, luxation toward the back, to overstraining, and rotation luxation, to exaggerated turning of the vertebra.

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OSTEOCHONDROMATOSIS OF ELBOW

By SAMUEL KLEINBERG, M D

OF NEW YORK, N Y

FROM THE HOSPITAL FOR JOINT DISEASES

OSTEOCHONDROMATOSIS of the elbow is of very great interest to the surgeon from several important aspects. Firstly, the condition of osteochondromatosis, referring to the occurrence or accumulation in joints, bursæ, or tendon sheaths of small or large numbers of loose osteochondral bodies, is comparatively rare. With few exceptions no one surgeon is likely to see more than a half-dozen instances in his whole career. Secondly, the origin, development, pathology and the etiology are all in doubt. Thirdly, the pathology is such as, at times, to interfere with or even preclude complete surgical cure. Because of these facts it seems worth while to report in detail several cases, with a critical review of their salient features. There is a special interest in my group in that two of the patients had a bilateral lesion of the elbow-joints, a circumstance that has so far not been recorded in the literature.

CASE I—Osteochondromatosis of the Right Elbow—Israel K., forty-seven years old, was referred to me in February, 1931, for pain in, and disability of, his right elbow. This patient was a pushcart peddler. While he had to do much lifting of moderately heavy objects, he had been accustomed to such work for many years, he used both arms with equal force, and he recalled no occasion at which he had strained or injured the right elbow. Two years previously he noticed a gradually increasing flexion contraction of the right elbow. During the six weeks immediately preceding my first examination the elbow became painful, there was a decided reduction in extension of the elbow, and forced extension aggravated the pain. He was a well-built, muscular, healthy-looking individual. He had no abnormalities anywhere except in the right elbow.

Right Elbow—This joint appeared normal. The range of movement extended from 60° of flexion to 120° of extension. Rotation of the forearm was entirely free. There was no local heat or tenderness to pressure. There was no motor, sensory or vascular disturbance in the forearm or hand. The lateral roentgenogram (Fig. 1) showed a large number of free bodies, small and large, located in the front of the elbow. There were also several loose bodies posteriorly in the olecranon fossa. This is not clearly seen in the print here reproduced. The diagnosis of osteochondromatosis was evident and an operation for the removal of the loose bodies was advised.

Operation—February 20, 1931—The approach to the elbow which I used here was designed to give easy access without injuring tissues and with practically no bleeding. A vertical incision was made on the front of the elbow somewhat lateral to the median line. The biceps tendon was retracted inward and the brachio-radialis muscle outward, exposing the brachialis anticus. The fibres of the latter muscle were separated laterally, bringing the capsule of the joint immediately into view. The capsule was incised vertically, affording a good view of the anterior compartment of the joint. About two dozen osteochondral loose bodies were removed. Some of these were attached to the synovial lining of the capsule. The bodies varied in shape and in size from one-eighth to one-half inch in diameter. They were, many of them, tucked away in various recesses of the joint, so that some maneuvering was necessary to dislodge them. When I was

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through, the front of the joint appeared free of any loose bodies. At this juncture flexion of the elbow was practically normal but extension was still markedly restricted. I, therefore, concluded that extension was obstructed by some loose bodies in the olecranon fossa. Accordingly, an incision was made on the back of the elbow and several large bodies were dislodged. The wounds were closed in layers and healed by primary union. Even after the removal of the bodies from the posterior compartment complete extension was impossible. The restriction was believed to be the result of contraction of the anterior capsule of the joint.

The patient made an uneventful recovery from the operation. At first the range of movements of the elbow was somewhat less than before the operation, but this soon increased. When last seen in April, 1932, the patient expressed himself as satisfied with the operation because he was not only able to work, but could lift heavy objects, and had very little discomfort. The gain in the movement of the elbow was comparatively



FIG 1—(Case I) Lateral pre-operative roentgenogram. Note numerous loose osteochondral bodies in the anterior compartment of the elbow. There are several loose bodies in the posterior compartment or olecranon fossa, the arrow points to their location. They are not clearly visualized in this view, but show up plainly in the antero-posterior film. There is no evidence of any joint irregularity or osteophytes, that is, there is no associated arthritis.

small. Flexion was unaltered. Extension, which had been limited to 120° , was now possible to an angle of 140° , a gain of 20° .

Comment—The small gain in joint function was disappointing and due evidently to the fact that some loose osteochondral bodies had been left in the elbow. Although at the time of operation I was certain that I had removed all the loose bodies, I had actually failed to do so. A post-operative roentgenogram showed several bodies, some of considerable size, that had been left behind in the anterior joint compartment. These bodies must have been walled off by intra-articular adhesions of the synovial membrane. I recall distinctly that the synovia was thickened and formed cells or compartments. The articular cartilage grossly seemed unimpaired. There were no osteophytes. The bodies removed had a central core of bone covered with cartilage.

CASE II—*Osteochondromatosis of Both Elbows*—George F, forty-one years old, was seen in my out-patient clinic at the Hospital for Joint Diseases. His chief complaint was pain in both elbows which had begun to trouble him two years previously. The patient was a laborer who worked with a pneumatic hand drill. His upper limbs were, therefore, subjected to severe jarring during his work. At times the drill would slip and he felt a shock in his elbows. One year ago he injured his left elbow while playing soccer. The condition of his elbows became aggravated so that when I first saw him he was unable to bring his hands to his face, and, in addition, had numbness in the right small finger. He was in good general condition with no lesion anywhere except in his elbows and the right hand.

Right Elbow—This joint was markedly limited in its movements, extension was checked at an angle of 165° , and flexion at a right angle, rotation of the forearm was free. Movement of the elbow was accompanied by marked crepitus, forced motion was painful. The right hand presented atrophy of the interosseous spaces and a flexion contraction of the little finger at the proximal interphalangeal joint. There was also diminu-

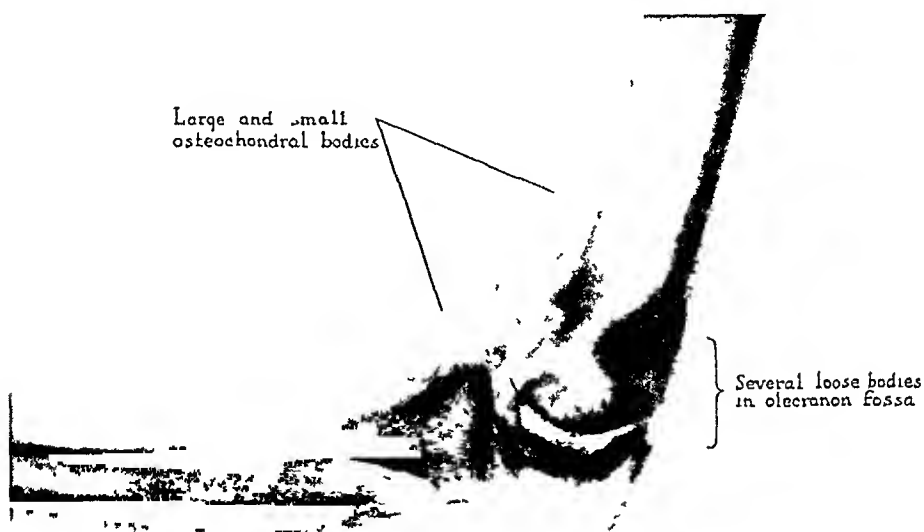


FIG. 2—(Case II) Lateral roentgenogram of right elbow. Left elbow shows similar lesion. There are seen numerous bodies of varying sizes in both the anterior and posterior compartments of the elbow. The articular cartilages are clear, and there is no roughening of bone at the articular junctions, so that there is no sign of any arthritis.

tion in the sensory function of the little finger. There was, therefore, paralysis of the ulnar nerve.

Left Elbow—This joint showed greater restriction of its movements than the right elbow. Extension was possible only to an angle of 140° , and flexion to 90° , rotation was free. Crepitus was present during all movements. There was no atrophy of the hand and no disturbance of its motor or sensory functions.

The X-ray pictures of the elbows showed similar lesions. In the lateral view of the right elbow (Fig. 2) here reproduced it is seen that there were numerous loose and attached bodies in the anterior compartment and several bodies in the back of the elbow.

This patient evidently had an osteochondromatosis of both elbows with the formation of many joint bodies which were mechanically reducing the function of both joints to an increasingly serious degree. In the right hand there was a secondary ulnar paralysis. Consequently, it was decided to operate on both elbows for the purpose of removing the obstructing bodies from within the joints.

January 24, 1930—The left elbow joint was exposed through a posterior incision. Numerous bony masses were found attached to the posterior surface of the humerus.

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and to the olecranon process. None of them was entirely loose, some were attached by narrow pedicles. They were all removed. The synovial tissue was found to be thickened and was excised. Similarly, several large bodies which were attached to the humerus in the anterior compartment of the elbow were removed together with much thickened synovia. The microscopical examination showed an extensive villous proliferative synovitis. Many of the bony masses were covered with cartilage that had eroded areas.

Right Elbow Operated on June 27, 1930—The right elbow-joint was exposed through lateral incisions. Nine bodies were removed from the anterior compartment. Some of them were loose, others were attached to the front of the humerus and to the coronoid process, while still others were loosely held in the radiohumeral recess. At

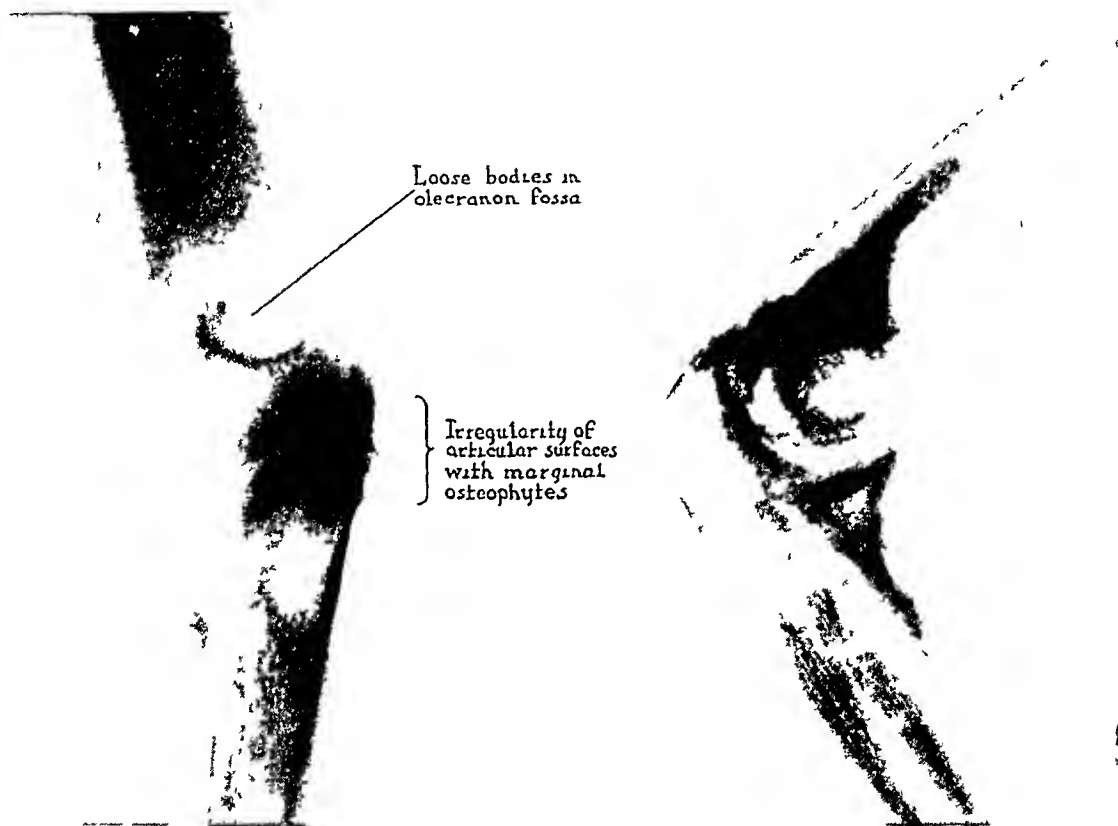


FIG. 3—(Case III) Right elbow. Note loose and attached joint bodies in the anterior compartment and the olecranon fossa. The articular margins on the inner side of the joint are irregular due to a hypertrophic arthritis. This is seen very clearly in the original films. The articular cartilage itself is not altered.

this stage of the operation the elbow could be flexed perfectly and extended to 170° . The removed bodies consisted of cartilage with bone cores.

This patient was seen in my follow-up clinic several months ago. He felt quite pleased as he had a distinct increase in the range of movement in both elbows, the pain had subsided and he was able to use his arms, elbows and hands with much greater freedom.

CASE III—Osteochondromatosis of Both Elbows—Charles A., forty years old, consulted me a year ago for stiffness in both elbows and numbness in the fingers of the right hand. Three and one-half years ago he injured his right elbow while playing handball. He had a "kink" in the elbow but the peculiar sensation disappeared and he paid no further attention to it. Some months later he began to feel some stiffness in this joint. More recently the elbow became painful and the little and ring fingers numb. The left elbow began to trouble him also several years ago, the chief difficulty being stiffness.

Examination revealed the following findings

Right Upper Limb—At the elbow flexion is checked at 60° and extension at 120° . Pronation is free, supination is slightly restricted. Extension is moderately painful. There is numbness in the small finger and the ulnar side of the ring finger. There are no motor or trophic disturbances.

Left Upper Extremity—At the elbow-joint flexion is possible to an angle of 50° , and extension to 150° . Forced motion is painful. There are no sensory, motor or trophic lesions.

The X-ray picture of the right elbow (Fig. 3) shows several loose bodies in the joint. There is, in addition, narrowing of the joint space and irregularity of the articular surfaces, especially on the inner side of the elbow and along the anterior surface of the humerus, indicating the co-existence of a hypertrophic arthritis. The picture of the left elbow shows the same type of lesion.

This patient refused operation so that we have no pathological material for gross or microscopical investigation.

Discussion—There are here recorded three cases of osteochondromatosis of the elbow-joint. All the patients were males, of particularly strong physique, their ages varying from forty to forty-seven years. The most notable characteristic is that two of the cases had a bilateral lesion. This has not previously been observed, or at any rate not reported in the literature. In both these cases the elbows were involved to the same degree. In addition, both patients had unilateral ulnar paralysis.

The etiology in my cases, as in practically all others, is obscure. A history of some form of trauma appears in about half of the cases. In two of my patients, Cases I and II, the occupation was such as to subject the elbows to frequent minor and occasional severe injuries. In the second case the man used a pneumatic drill. It was, therefore, inevitable that the elbows should suffer prolonged mild irritation and an occasional marked trauma. But my third case had a very advanced bilateral osteochondromatosis without any injury. And even in the first case there was no direct damage to the right elbow. The man was a laborer, doing hard work, to which he was accustomed. Furthermore, although he used both arms equally, only the right elbow developed signs of osteochondromatosis. It appears to me more reasonable to believe that the lesion occurs on an embryological basis. We may logically assume in these patients a susceptibility to the formation of osteochondral bodies through the presence in the synovial capsule of aberrant mesenchymal rests. These rests or chondrogenous islands are stimulated by some agency, perhaps in some cases trauma is the agency, to growth and transformation into cartilaginous or osteocartilaginous bodies. In my third case the presence of a hypertrophic arthritis indicated the existence of an irritative process of which the osteochondromatosis was one manifestation.

In all the cases I have ever operated upon the synovial lining was greatly thickened and there was no involvement of the articular cartilage. There were many villi, some sessile and others with slender pedicles. These villi are the outgrowths of the mesenchymal rests, and ultimately give rise to the osteochondral bodies, some of which are loose, and others still attached to the synovial lining. The osseous deposit in the centre of the joint body is an end-product of the metamorphosis of the synovial villus. The term

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synovial osteochondromatosis, initiated by Henderson of The Mayo Clinic, is, from the point of view of the genesis of the joint bodies, entirely correct as it indicates the primary site of the pathological change. The theory of the synovial origin of osteochondromatosis is tenable even in my third case in which there is a hypertrophic arthritis. For in the lateral roentgenogram is visible a hypertrophic process on the front of the humerus at some distance from the articulation. Here, one may readily believe, the lesion started as a hypertrophic villous synovitis, with conversion of some of the villi into bone, at least one of which appears to have broken loose.

The clinical picture in my patients, as in most others, appeared insidiously with a sense of stiffness in the elbow. There was no single precipitating factor. Discomfort in the elbow was experienced at the start only at the extremes of flexion and extension. In the later stages pain in the joint was pronounced, especially in attempts at forced movements. The stiffness gradually increased until the motions of the elbow were seriously restricted and the joint function hampered, resulting in disability.

As the disturbance in the function of the elbow in osteochondromatosis arises from the mechanical interference with its free motion, the treatment is necessarily entirely surgical. One must remove all, or as many as possible, of the joint bodies, loose and attached. The result may be perfect. If one encounters the difficulties present in my cases there will be only partial relief. The latter eventuality is not surprising if one bears in mind the facts that the disease is essentially a synovial lesion, and it is not possible to completely excise the synovial lining of the elbow-joint, and that some of the joint bodies may be tucked away in completely walled-off recesses. After the operative wound was healed the return of function may be materially enhanced by the judicious prolonged application of physiotherapy including gradually increased motion.

CONCLUSIONS

(1) Osteochondromatosis of the elbow is primarily a disease of the synovial lining membrane.

(2) Its origin may be attributed to the presence in the synovia of rests or islands of chondrogenous cells. While this embryological concept is theoretical, it seems to be the most likely of the various potential causes.

(3) Trauma occurs in more than half of the cases but is only a contributory factor and not an active causative agent.

(4) Two of my cases showed a bilateral lesion.

(5) A surgical approach was described giving access to the elbow with the minimum of injury to the tissues and without any hæmorrhage.

(6) In cases with marked hypertrophy of the synovial membrane the restriction of joint motion and function cannot be cured by the removal of the osteochondral loose bodies.

(7) Operative treatment, however, by removing the main impediments to joint mobility, always results in improvement and should be applied early.

SAMUEL KLEINBERG

(8) Physiotherapy is an important aid in the post-operative treatment favoring a rapid recovery of the maximum function

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RADIAL PARALYSIS COMPLICATING FRACTURE AND DISLOCATION IN THE UPPER LIMB

BY ELISHA STEPHENS GURDJIAN, M D

AND

ANGUS G GOETZ, M D
OF DETROIT, MICH

FROM THE DEPARTMENTS OF NEUROSURGERY AND ORTHOPEDIC SURGERY OF THE DETROIT RECEIVING HOSPITAL

THE radial nerve may be injured in a number of ways. In open wounds it may be sectioned, lacerated or bruised. In dislocation of the shoulder-joint the radial may be stretched and contused. With a lesion of this type however, there is practically always associated injury to other branches of the brachial plexus. Pressure neuritis of the radial is occasionally seen due to constant pressure for a given time against the nerve in sleep, intoxication, and peculiar posture. The nerve may also be damaged in association with fracture of the humerus and fracture and dislocation about the elbow-joint.

In this paper we are interested in radial paralysis complicating fractures and dislocations of the upper limb. A review of the literature reveals many reports on individual cases. The discussions of Lewis and Miller,² Scudder,³ Platt,⁴ Lewis¹ and others⁵ are instructive and present a rational viewpoint in the treatment of such cases. Two types of radial paralysis are seen in association with fractures of the humerus and fracture and dislocation about the elbow-joint. The primary type includes cases with paralysis caused by impact against the nerve at the time of the blow. The secondary type of radial paralysis is manifested several days or weeks after the accident and it is brought about by callus inclusion and scar tissue contraction about the nerve in the process of healing. In the majority of the cases however, it is difficult to determine the time of appearance of disability due to lack of proper neurological examination.

The radial is the most common nerve injured in fractures and dislocations. The thorough review by Lewis and Miller² shows that in 253 cases of fracture complicated by nerve involvement 136 had radial paralysis. Scudder³ estimated that there are varying degrees of radial paralysis in approximately 4-7 per cent of the cases with fracture of the humerus. Platt's⁴ group showed a frequency of 5 per cent. In our own series of sixteen, fourteen of the cases occurred in the receiving hospital in a period of two and a half years. During this period there were 392 cases of fracture of the humerus admitted to the hospital. The percentage in this hospital is therefore between three and four, although it is very possible that some minor cases of radial palsy showing improvement within a few days are not included in this series. Were every case of humeral fracture tested out for radial dysfunction the number would undoubtedly be higher.

The frequency of radial nerve involvement in fractures can be easily understood when one considers the fact that through at least a third of its course down the arm it is in apposition to bone. As has been well brought out, the nerve may be injured at the time of the accident by stretching, bruising, by being caught between fragments. It may even be actually severed, and this was the case in thirteen out of forty-four patients with primary paralysis of radial nerve (Lewis and Miller²). The nerve may be injured by unnecessary manipulations for an anatomical result.

In one case in this series a patient entered with no paralysis and in view of poor position of fragments he was manipulated under the fluoroscope. After this manipulation he had a definite radial paralysis. In a certain number in this series the injury was evident only after several days or weeks following the accident. This emphasizes the importance of considering fracture cases a potential source of nerve injury. It should not take longer than thirty seconds to tell whether the patient has a certain nerve involvement. Such simple requests as move your fingers, move the hand back, do you have any numbness in your hand, *etc.*, will enable the examiner to rule out a nerve injury.

In the papers consulted it is the consensus of opinion that radial palsy complicating fracture of the upper limb should be conservatively treated for a period of about three months. If by the end of this probationary period there are no evidences of returning function the nerve should be explored at the site of fracture and treated according to pathological findings. Longer periods of conservative treatment may cause irreparable damage to the nerve. This is an accepted opinion. It is probably true that in the majority of the cases waiting for three months would not materially alter the status of regeneration of the radial nerve. However, were it possible to tell which case would require ultimate operative intervention, the best policy would undoubtedly be earliest intervention compatible with careful work. For it is true that early operation will invariably shorten the period of disability. We feel that patients with radial palsy complicating fractures of the upper limb should be given individual attention and treatment rather than be treated according to an unbending law or dictum. If cases are individually studied and if certain findings are on hand, the conclusion of earlier intervention is sane and denotes the shortening of the period of disability and the latter is of great economic importance in the majority.

SYNOPSIS OF CASES OF RADIAL PARALYSIS FOLLOWING FRACTURE OR DISLOCATION OF UPPER LIMB TREATED BY OPERATION

CASE I—J. R., aged twenty-eight. Etiology—Bullet. Site of fracture—Junction of upper and middle thirds. Indications for operation—Radial level of triceps nerve supply. No evidence of return of function. Time between accident and operation—Fourteen weeks. Operative findings—Nerve bound down at entrance to radial groove. Spicules of bone and scar tissue compressing. Good result. Period of total disability—Forty-eight weeks.

CASE II—S. H., aged thirty-seven. Etiology—Fall. Site of fracture—Middle third, excellent position. Indications for operation—Radial palsy (Fig. 1) with increasing

RADIAL NERVE PARALYSIS

severity the last four weeks Time between accident and operation—Thirteen weeks Operative findings—Neuromatous enlargement at site of trauma (Fig 2), beginning atrophy of distal portion of nerve Neurolysis sufficient Good result Period of total disability—Forty-five weeks

CASE III—J R, aged three Etiology—Fall Site of fracture—Supracondylar Indications for operation—Radial palsy with increasing severity Time between accident

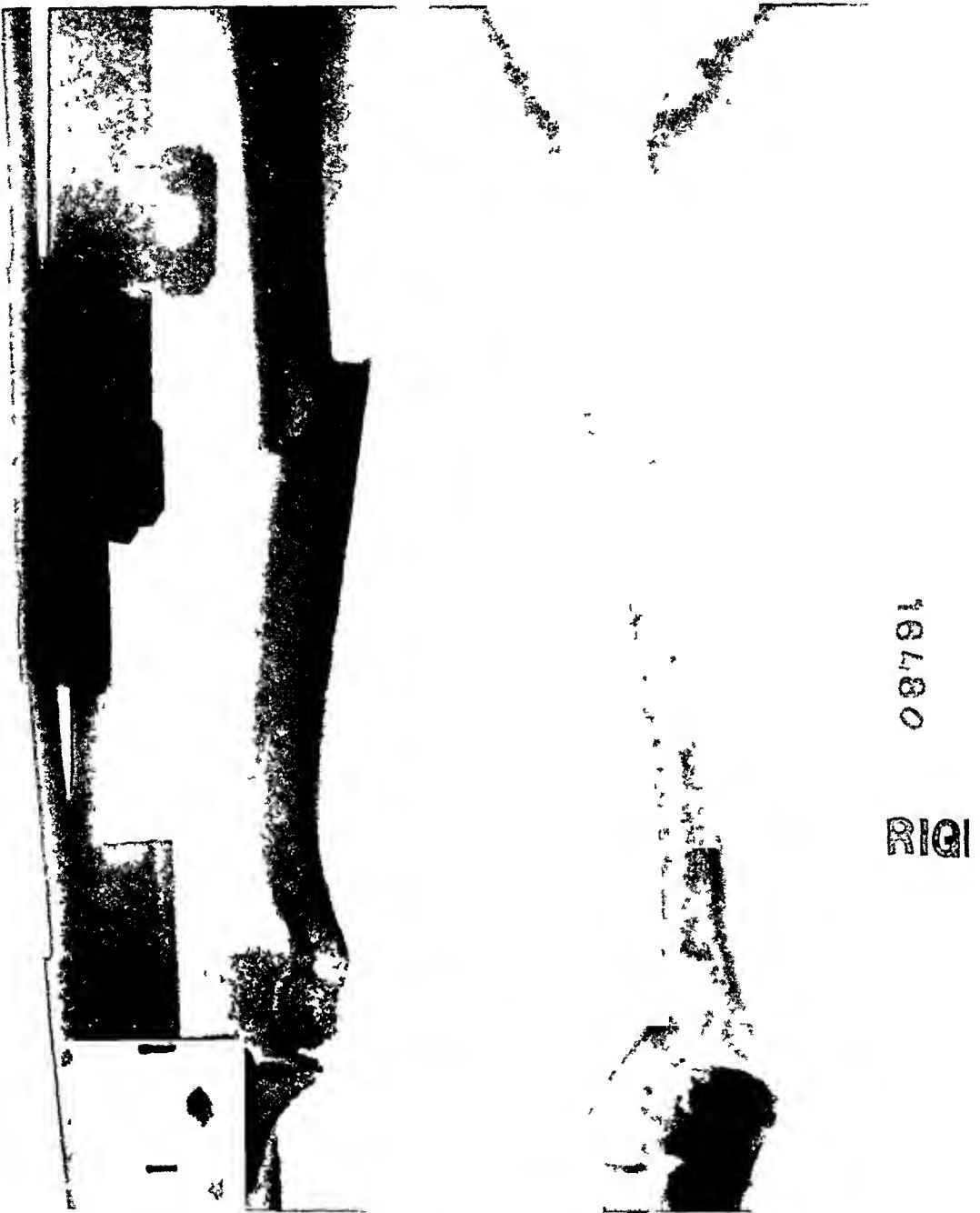


FIG 1—Films of Case II to show fracture of the middle third of the humerus associated with radial palsy. The latter was due to neuromatous degeneration of the nerve at the site of fracture. Even though the bone may heal in perfect anatomical alignment, this is not an argument in favor of conservatism.

and operation—Thirteen weeks Operative findings—Nerve bound down to bone with spicules of bone in the meshes of scar tissue Good result Period of total disability—Eighteen weeks

CASE IV—J M, aged thirty-six Etiology—Auto Site of fracture—Middle third excellent position Indications for operation—Radial palsy with no evidences of return in function Time between accident and operation—Eleven weeks Operative findings—

Nerve found traversing a bony and scar tissue canal Good result Period of total disability—Sixteen weeks

CASE V—G B, aged twenty-one Etiology—Auto Site of fracture—Junction, middle and lower thirds Indications for operation—Radial palsy with no evidences of return Non-union Time between accident and operation—Eleven weeks Operative findings—Nerve found in much scar tissue at site of non-union, neuromatous enlargement Good result Period of total disability—Fifty weeks

CASE VI*—J D, aged four Etiology—Burn, no fracture Indications for operation—Increasing radial nerve palsy A true secondary nerve paralysis Time between accident and operation—Fourteen weeks Operative findings—Scar tissue contraction



FIG 2—This is to show the operative findings in Case II Grossly there was an enlargement at the site of fracture Neurolysis disclosed swollen nerve bundles traversing the area of pathology It was therefore thought advisable not to resect this portion of the nerve Complete recovery ensued

of radial at entrance into radial groove Good result Period of total disability—Sixteen weeks

CASE VII—C S, aged forty-three Etiology—Auto Site of fracture—Old fracture of ulna and anterior dislocation of radius Indications for operation—Radial palsy and old anterior dislocation of radial head Time between accident and operation—Ten weeks Operative findings—Nerve pushed forward by the head of the radius (Fig 3) in the meshes of delicate scar tissue

This case is included in the series as an example of true secondary radial palsy Patient had third-degree burns on the posterior aspect of shoulder and arm At first there were no evidences of radial dysfunction Within ten weeks a beginning radial palsy became progressively worse, until the nerve was freed and transposed into a live muscle bed

RADIAL NERVE PARALYSIS

CASE VIII—C J, aged forty-one Etiology—Bullet Site of fracture—Supracondylar, bullet on the medial aspect of arm near shoulder-joint Indications for operation—Radial palsy, also evidences of dysfunction of median, musculocutaneous and medial antibrachial cutaneous nerves Time between accident and operation—Six weeks Operative findings—Radial nerve bound down by delicate scar tissue Bullet found in the substance of median and also compressing on the other nerves Good result Period of total disability—Twenty-one weeks

CASE IX—E M, aged twenty Etiology—Auto Supracondylar fracture Indications for operation—Open reduction elsewhere Radial palsy and excessive callus formation Nails in bone Time between accident and operation—Seven weeks Operative findings—Nerve bound down by scar tissue and callus Good result Period of total disability—Twenty-two weeks

CASE X—S T, aged fourteen Etiology—Auto Site of fracture—Junction of middle and lower thirds Indications for operations—Radial palsy following manip-

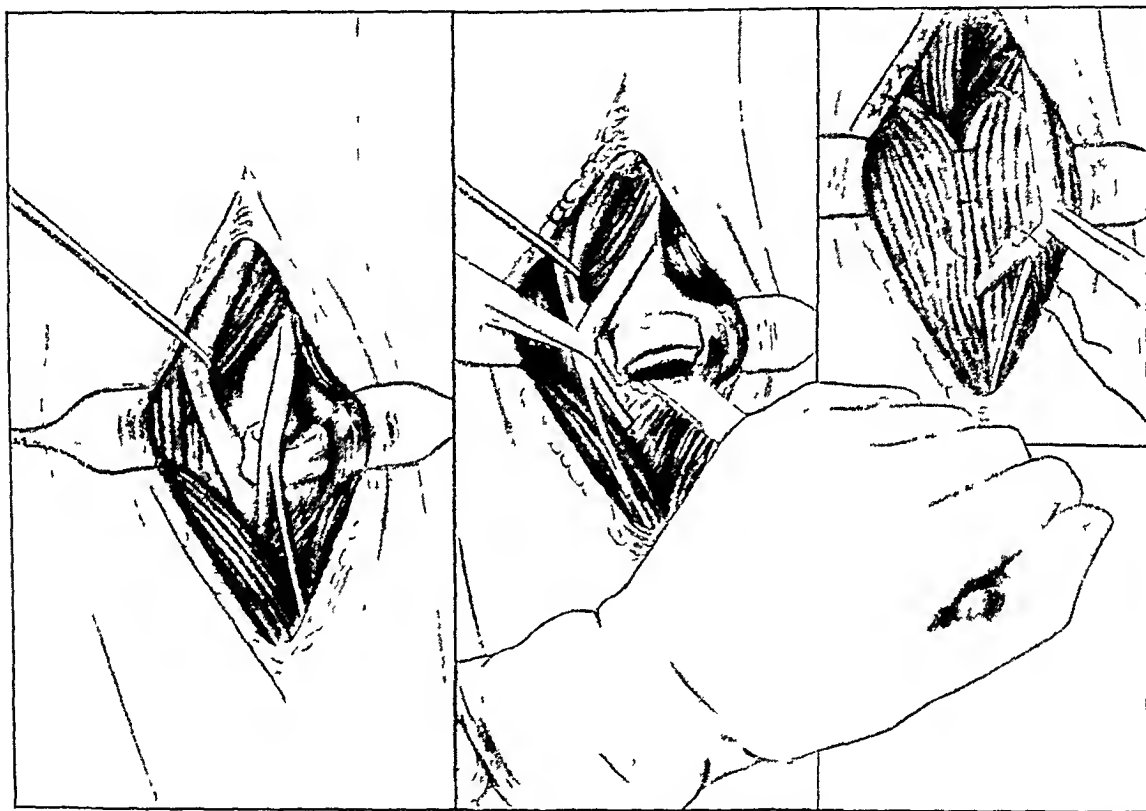


FIG. 3.—Operative findings in Case VII The terminal portion of the radial and its two branches were pushed forward by the anterior dislocation of the head of radius Patient recovered completely from the radial palsy

ulation Time between accident and operation—Four weeks Operative findings—Nerve bound down by scar tissue and callus at lower end of radial groove Good result Period of total disability—Eighteen weeks

CASE XI—F S, aged fifty-six Etiology—Fall Site of fracture—Junction of middle and lower thirds Indications for operation—Radial palsy, overriding and comminution of fragments, allowed to heal in good functional alignment Time between accident and operation—Five weeks Operative findings—Nerve caught between two fragments of bone Much scar tissue and callus Good result Period of total disability—Twenty-one weeks (Fig 4)

CASE XII—J C, aged forty Etiology—Auto Site of fracture—Junction of middle and lower thirds Indications for operation—Radial palsy, overriding and evidences of non-union Time between accident and operation—Five weeks Operative findings—Nerve found in much scar tissue and spicules of bone Results—Not known

CASE XIII—J G, aged fifty Etiology—Auto Site of fracture—Junction of middle

and lower thirds. Indications for operation—Radial palsy. Poor position of fragments, making an open reduction advisable. Time between accident and operation—Nine days. Operative findings—Nerve found red and swollen at the site of fracture. Good result. Period of total disability—Fourteen weeks.

CASE XIV—M. M., aged fifty. Etiology—Auto. Site of fracture—Old anterior dislocation, radial head. Indications for operation—Radial palsy. Old anterior dislocation of head of radius. Time between accident and operation—Nine weeks. Oper-



FIG. 4—This is to show the operative findings in Case XI. The nerve was found caught between fragments of bone. Previous rays showed comminution and overriding at the site of trauma. Functional alignment was restored by traction and four weeks after the accident the nerve was explored. The operative findings in this case were such that conservatism could only aggravate the neural disability.

ative findings—Deep and superficial radial nerves bound down by scar and callus. Results—Not known.

The accompanying table summarizes the findings in the operated cases studied, it is evident that in seven a period of two and a half months and over

had elapsed before operative intervention. In a certain number in this group operative treatment could have been advantageously used earlier. In the first case where the radial paralysis followed a bullet wound an exploratory could have been performed within about two or three weeks after injury. In Case II where instead of evidences of return of function there were signs indicative of increasing severity the patient could have been operated on much earlier. On the basis of pathological findings there was certainly no hope for amelioration. Case III also showed evidences of increasing severity and could have been treated earlier. In Case V there were evidences of non-union, and to have allowed such a case to go on any further may have meant eventual destruction of the nerve which was found in a bed of scar tissue and callus.

In the next seven cases operative intervention was effected before the end of three months. In Case VIII the disability was caused by a bullet wound and there was also evidence of median nerve disability. In Case IX there was a history of open reduction elsewhere for a supracondylar fracture. There was excessive callus formation about the elbow-joint and the probability of definite scar and callus inclusion was excellent. In the next case the radial palsy followed manipulation and it was not rash surgery to expose the nerve. In Case XI there was marked comminution of fragments and overriding. Good functional alignment was obtained by traction and the fracture was allowed to heal and four weeks later the nerve was exposed. There was no question that were this case allowed to carry on for three or four months irreparable damage would have ensued. In Case XII the indication for operation was non-union. In Case XIII poor position of fragments complicating primary radial paralysis made an open reduction preferable. In Case XIV the radial palsy was due to old anterior dislocation of the head of radius.

It is to be noted that the period of disability in the group where operation was performed before the three-month period is definitely shorter than in the preceding group where the three-month rule was followed. Among the later, disabilities of a year's duration are common, whereas in the group where early operation was used the upper limit of total period of disability is six months. Even though some cases may have recovered without intervention the operation in reality has done no damage. In the properly selected case I doubt if one would intervene where spontaneous recovery would obtain.

Because of the above considerations we believe in the following plan of attack in cases of fracture complicated by radial palsy. Given a primary paralysis due to a fracture in the upper third of the humerus above the level of the radial groove, conservative treatment for a period of from three to four months is definitely in order. In this position nerve and bone are widely separated by intervening muscular tissue. In such cases there would be paralysis of the triceps muscle and beginning recovery should certainly be noticed during this probationary period. On the other hand were it good surgery (in the opinion of the orthopaedist) to do an open reduction in such

a case, it is advisable to explore the nerve and transpose it into a live muscle bed. In fractures of the middle third complicated by radial palsy the presence of definite displacement of fragments with possible comminution is a good argument for scar and callus inclusion of nerve. In such cases as soon as sufficient callus has formed the nerve may be explored in the absence of returning function during this period. If there are no evidences of callus formation within a reasonable period of time an open reduction is indicated, for the middle third of the humerus shows non-union more frequently than any other portion of long bones. The presence of radial palsy in such a case should be a hastening factor for intervention. As a matter of fact, even in the absence of nerve palsy the radial should be dissected out and transposed into a live muscle bed when an operation is performed for non-union in the middle third of humerus. In fractures of the lower third with associated palsy, evidences of marked angulation, poor apposition, particularly in close vicinity to the elbow-joint, should favor an open operation which not only will insure good nerve function but will also enable the operator to get better functional alignment of bones. Here if the operation is done early it would be for the express purpose of reducing the fracture and at the same time transposing the nerve. If it is done four or five weeks after the accident it is in reality for purposes of transposing the nerve. We do not feel that early intervention is rash surgery particularly in fractures of the middle third and possibly also in fractures of the upper portion of the lower third associated with primary radial paralysis. As a rule we prefer waiting for a period of four to five weeks to obtain sufficient union of bones unless it is better surgery (according to the orthopædist) to intervene earlier for purposes of open reduction. In secondary paralysis it is advisable to study the patient for a few weeks for returning function. However, it must be confessed that most frequently neither patient nor consulting physician can state time of appearance of disability. Intervention later is justifiable. In the presence of radial palsy complicating old anterior dislocation of the head of the radius operative removal of the head of the radius seems justifiable.

In two cases conservative treatment was followed by return of function. In one there was fracture of the greater tuberosity of the humerus and anterior dislocation of the head. There was marked radial palsy and partial median. There were evidences of returning function after the third day. In another the fracture was in the lower third of the humerus with fragments in good apposition. There were evidences of returning function beginning the third week.

In the operative technic extreme asepsis is essential. We always prepare the field of operation two or three times before intervention. If the nerve is found of normal texture it is simply transposed into a live muscle bed. It is probably true that in the greatest majority no scar tissue contraction can occur with the nerve traversing a live muscle bed. If the nerve shows a small degree of enlargement (neuromatous degeneration) at the site of injury, it is advisable to perform a neurolysis to determine whether normal bundles

traverse the area of pathology. If so, a simple neurolysis is sufficient. In two such cases, in this series, neurolysis was sufficient. On the other hand, if the enlargement is a true neuroma it may be necessary to resect it. We have had no occasion to suture the nerve in this series. If the nerve is actually severed, after shaving off the ends with a razor, an end-to-end suture may be effected. In the presence of marked loss of nerve tissue it may be necessary to dissect the nerve up and down in order to get more length. If this is not sufficient the nerve may be transposed anteriorly and in so doing one would have to dissect back the branches to the triceps. It is important to save these fibres, as emphasized by Pollock and Davis,⁵ for the disability brought about by triceps palsy is serious, possibly more so than the wrist-drop. The way cases of radial paralysis are treated at the present time it never should be necessary to resort to section of humerus. Lewis¹ advises against this procedure.

In cases of radial palsy complicating old anterior dislocation of the head of the radius we use the following operative approach. An incision about five inches long is made on the anterior aspect of the elbow along the medial border of the brachioradialis muscle. The nerve is located above the elbow between the brachioradialis and brachialis muscles. Then it is traced down along the anterior aspect of the elbow-joint and repaired according to pathological findings. The removal of the head of the radius is just as simple as by the usual lateral approach. However, the nerve has to be dissected out and retracted as shown in Fig. 3.

After the nerve is freed it is transposed into a live muscle bed. A few sutures approximating the deeper portions of the brachialis and brachioradialis muscles, posterior to the nerve, effect the desired result.

Depending upon level of injury the first evidences of return in function appear in the most proximal portion supplied by the nerve (as is well known). Thus in injuries of the middle third a beginning contraction of the supinator longus is evidence that the nerve is coming back. During the period of expectant therapy or after the operation of transposition the hand is supported by proper splints and with beginning evidences of contraction of the supinator longus muscle all splints are removed so as to enable the patient to use the limb as much as possible. During the period of disability physiotherapy, massage and electrical stimulation of the paralyzed muscles are, of course, in order.

Summary—(1) This paper is based on fifteen cases of radial palsy complicating fractures and dislocations of the upper limb. The distribution of bony pathology is as follows: Fracture of the upper third of humerus, one case, fracture of middle third and junction of same with lower third, eight cases, supracondylar fracture, four cases, old anterior dislocation of the head of radius, two cases. One case of radial palsy due to scar tissue contraction about the nerve is also included as an example of typical secondary radial paralysis.

(2) Radial palsy complicating fracture of the humerus above the level of radial groove may be conservatively treated for three to four months. Radial palsy complicating fractures of the middle third of the humerus should be

explored within four to six weeks. Particularly is this true in the presence of comminution and overriding of fragments. Radial palsy complicating fractures of the humerus near the elbow-joint can advantageously be treated early, in selected cases. Not only will this insure good nerve function, but it will also enable the operator to get better functional alignment of bones. Radial palsy complicating old anterior dislocation of the head of the radius may be effectively treated by removal of the head of the radius through an anterior approach.

(3) In fractures of the humerus (particularly the middle third) manipulation of fragments should be done as little as possible. Functional alignment of bones by traction is more desirable to obviate nerve injury.

(4) Neurological examination in cases of fracture will always disclose primary nerve involvement. As a rule a few questions and answers are sufficient to diagnose the case.

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FRACTURE OF THE CAPITELLUM OF THE HUMERUS*

BY WALTER ESTELL LEE M D AND THOMAS J SUMMEY M D
OF PHILADELPHIA PA

THOUGH it would seem from the literature that the capitellum of the humerus is rarely fractured for we have been able to find reports of but twenty-eight cases there is the possibility that it is not so frequently diagnosed as it should be

Fracture of the capitellum of the humerus was first reported in 1853 by Hahn¹ of Germany following an autopsy that he performed on a woman of sixty-three He had treated her some years previously for fracture of the elbow and had obtained a very unsatisfactory result Being curious to see the cause of the failure he found at autopsy that a fragment of a fractured capitellum which was dislocated upward and anteriorly had locked the joint causing ankylosis (Fig 1)

We are reporting five cases which have come under our observation

CASE I—A white boy seven years old was brought to the accident ward of the Graduate Hospital of the University of Pennsylvania on June 14 1930 His mother stated that on that day the child had fallen from a couch to the floor a distance of about three feet striking his elbow There were swelling and pain in the region of the elbow with almost complete fixation of the joint when he was first examined at the hospital A diagnosis of fracture involving the bones of the elbow-joint was made and the extremity was placed in the Jones position A few days later the X-ray department reported 'A fracture of the capitellum (Fig 2)

The boy failed to return for treatment and the social service department found that he had moved to another city About four and one-half months later we were finally successful in locating the child and he was readmitted for treatment It was found at this time that the arm was practically fixed in the Jones position and although the acute swelling had disappeared there remained a widening of the joint and marked limitation of the motions of pronation and supination The limit of flexion was about 45° and of extension about 145° An X-ray examination at this time was reported as follows Fracture of the capitellum humeri (Fig 3) Operation was advised and the boy was admitted to the hospital October 21 1930 The operation was performed November 4 1930 by Dr Walter Estell Lee and Dr Thomas J Summey Under ether anaesthesia a Kocher incision three inches in length was made over the external condyle The joint

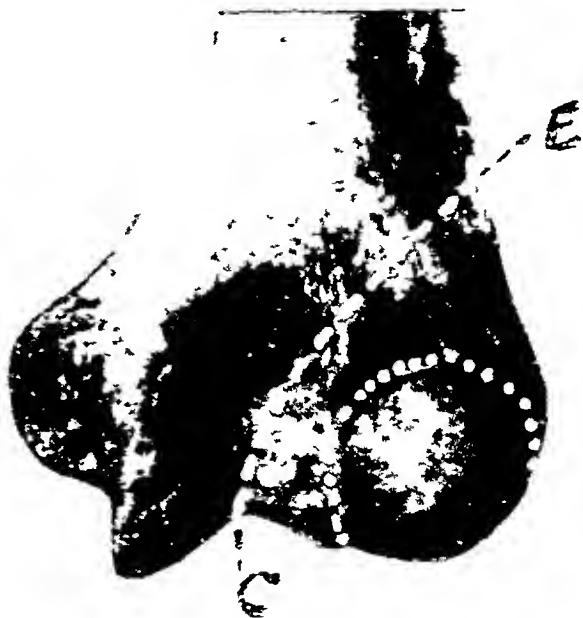


FIG 1—Normal humerus showing the position of the external condyle and capitellum (Ciacca)

* Read before the Philadelphia Academy of Surgery November 6 1933

cavity was entered and the fractured capitellum was found displaced upward and anteriorly and adherent to the capsule by a fibrous band. The capitellum was removed (Fig 4), and the joint capsule was closed with chromic gut, the muscles with plain catgut, and skin with interrupted sutures of dermol. The arm was placed in full extension and held in this position by means of a molded plaster splint.

Recovery was uneventful and the patient was discharged November 14, 1930. He was re-admitted four times thereafter for manipulation of the joint under gas anæsthesia. The first three times the arm was replaced in the molded plaster splint, and he was finally discharged December 30, 1930, with an excellent functional result, all movements of the elbow-joint and forearm being practically normal. January 1, 1932, a year later, the patient was seen by one of us (T J S) and the function was found to be normal, there being no limitation of motion in any of the movements of the elbow-joint or forearm (Fig 5).

CASE II—White girl, eighteen years of age, came to the receiving ward of the Pennsylvania Hospital September 17, 1924, complaining of partial loss of function of the left elbow-joint. She stated that, some three months before, June 15, 1924, she fell down a flight of steps, landing on her left elbow. She applied for treatment at the dispensary of another hospital, where an X-ray examination was made and she was told that no fracture was present,



Fig 2—(Case I) Lateral view



Fig 3—(Case I) Anteroposterior view

and the arm was dressed upon an internal right-angle splint. For the following two weeks the arm was redressed at the same hospital, but upon removal of the splint at the end of two weeks she was unable to move the arm satisfactorily, and being dissatisfied, she consulted us.

At the time of our first examination we found the left elbow considerably thickened and the olecranon process not so prominent as on the opposite side, and there was marked tenderness in the antecubital fossa. Active and passive motions of extension and flexion of the left elbow were limited to about 50 per cent of their normal range, pronation and supination were painful and very markedly limited, due to partial ankylosis. The report of an X-ray examination made at this time was "Fracture of the capitellum. The fragment is displaced forward so that the fractured surface of the distal fragment is practically at right angles to the articular surface of the radius. The condition is better seen in the lateral view, but it is very difficult, in fact, practically impossible to make it out in

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the anterior posterior view" Probably the lack of a lateral view at the time of the first X-ray examination explains the overlooking of this fracture

Operation was advised and she was admitted to the hospital October 6, 1924, and operated upon October 11, 1924, under gas-ether anæsthesia The operation was performed by Dr Walter Estell Lee An incision was made over the lateral aspect of the left elbow which was about three inches in length Dissection was carried down through the scar tissue until the joint cavity was entered, where the capitellum was found dislocated forward and rotated medially and so placed that it locked the joint The fragment was disengaged and removed without any difficulty, after which the joint capsule was closed with a continuous chromic catgut and the skin with a continuous silk suture Four days after operation the swelling and pain had disappeared and the incision was in excellent condition and passive motion was started On the fourteenth day the soft tissues having healed entirely, the adhesions were broken up by forcibly extending and flexing the elbow under gas anæsthesia, thereby securing full extension, flexion, pronation and supination Two weeks later, November 13, 1924, under gas anæsthesia, the adhesions



Fig 4—(Case I) Capitellum removed at operation

were again loosened The motions at this time were normal and the patient was discharged from the hospital November 15, 1924 and we have had no further report and have been unable to get in contact with the patient since that time

CASE III—White woman, aged seventy, April 14, 1931, while walking on a slippery pavement, fell, striking her elbow against the pavement She complained of pain and noticed swelling which extended from below the shoulder down to the lower third of her forearm The family physician, who saw her immediately after the accident, treated her conservatively, waiting until the swelling had sufficiently decreased for further treatment After a week, the swelling and discoloration having disappeared, the patient was referred to one of us (TJS) for treatment On examination motions of the elbow-joint were found to be limited to about 60° of flexion and 140° of extension Motions beyond these points were painful Pronation and supination were also limited to about one-half of the normal There was marked tenderness over the antecubital fossa, but no tenderness could be felt over any other bony point of the elbow-joint

An X-ray examination at this time, April 20, 1931, made at the Burlington County Hospital Mt Holly, N J, was reported as follows (Fig 6) "Examination of left elbow shows a comminuted fracture of the capitellum of the humerus with the lateral half of the capitellum broken off and displaced anteriorly on the flexor surface of the

shaft of the humerus" Operation was advised, but refused, and we were able to use only baking and massage No attempt at immobilization was made After six weeks the patient had about 60 per cent range of all movements of the elbow-joint and of the forearm, and she is now considering the advisability of having surgical intervention, but has not consented up to the time of this report (Fig 7)

CASE IV—White girl, eight years old, was brought to the receiving ward of the Pennsylvania Hospital June 24, 1928, with the history of having fallen a short time before while playing in the street and striking her right elbow on the pavement The patient complained of a great deal of pain, held the joint in a fixed position and would not



FIG 5—(Case I) Three years after operation showing hypertrophy of the external condyle and a new capitulum



FIG 6—(Case III) Fracture of the capitulum not operated upon

allow it to be moved The clinical examination was very unsatisfactory because of lack of cooperation from the patient X-ray examination revealed a fracture of the capitulum with anterior displacement of the fragment (Fig 8) Operation was advised, the child's mother signed a release and the child left the hospital We have been unable to trace this child since that time (Fig 9)

CASE V—Mrs C sixty-two years of age, was admitted to the Bryn Mawr Hospital December 16, 1933 following a fall in her home It was very difficult to obtain an accurate history from her because of her lack of memory, but apparently she fell, striking the outer side of her left elbow Dr Sands who first saw her was at loss to explain the fact that while the landmarks of the elbow-joint seemed to be undisturbed, and though she had free flexion and extension, there was very definite crepitus Upon admission to the

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hospital an X-ray picture showed not only a fracture of the external condyle but a fracture of the capitellum with the fragment dislocated inward, anteriorly and upward (Fig 10) There was a good deal of ecchymosis and swelling about the elbow-joint so that operation was deferred until December 21, when through a Kocher incision, about three inches in length made over the external condyle the fragment was found lying outside the joint capsule and displaced anterior, medial and superior to its normal position The fragment contained a part of the trochlear surface, but not enough to interfere with the stability of the humero-ulnar articulation (Fig 11) There was a good deal of bruising of the muscles about the capsule of the joint with ecchymosis but it was possible to expose the rent in the joint capsule and to approximate it and the muscles with a catgut suture and the skin and subcutaneous tissues with dermol sutures Five weeks after the operation this patient had normal function



FIG 7—(Case III) Fracture of the capitellum unoperated Lateral view



FIG 8—(Case IV) Fracture of the capitellum unoperated Anteroposterior view

ANATOMY *—The lower extremity of the humerus is flattened from before backward, and terminates in a broad sloping articular surface which is subdivided by a low ridge into the trochlea and the capitellum

The trochlea is the pulley-like surface which extends over the end of the humerus and articulates with the semilunar notch of the ulna The trochlea is constricted in the centre and expanded laterally to form two prominent ridges, the medial one of which is thicker and descends lower, forming a marked projection, the lateral edge is narrower, corresponding in shape to the interval between the ulna and the radius Above the trochlea are two fossæ, on the anterior surface is the coronoid fossa, an oval pit

* This description is taken almost verbatim from Gray's Anatomy

which receives the coronoid process of the ulna when the forearm is flexed, while on the posterior surface is the olecranon fossa, a deep hollow for the reception of the anterior extremity of the olecranon process during extension of the forearm. These fossæ are usually separated by a thin translucent plate of bone, occasionally by fibrous tissue only, so that in a macerated specimen a perforation, or supratrochlear foramen, might exist.

By comparison, the capitellum or the radial head of the humerus, on which the concave head of the radius plays, is much smaller and not far from being a portion of a sphere (being convex or nearly equally so in all directions, the arc from above downward being the longest). The capitellum is placed so much to the front of the humerus as to be nearly or quite invisible from behind, hence the articular surface is much more extensive on the front than on the back. The capitellum articulates perfectly with the concavity on the proximal end of the radius. Anteriorly on the humerus and immediately above the capitellum is a small depression, the radial fossa, which receives the anterior edge of the head of the radius in extreme flexion, whilst the medial margin of the head of the radius moves in a shallow groove between the capitellum and the trochlea. This last groove runs between the capitellum and the outer edge of the



FIG 9—(Case IV) Fracture of the capitellum unoperated. Lateral view.

trochlea, the outer border being straight, the posterior running obliquely backward and inward.

Thus it will be seen that the bones comprising the elbow-joint are the lower end of the humerus above and upper end of the radius and the ulna below, the articular surface of the humerus being partly received within the semilunar notch (great sigmoid cavity) of the ulna, and partly upon the cup-shaped area (fovea) of the radial head. It will also be noted that the elbow includes two articulations—the humero-ulnar, a pure hinge joint, and the humero-radial, a ball-and-socket joint. Besides these two articulations which enter into the mechanism of the hinge movement, there is always present within the capsule of the joint the proximal radio-ulnar articulation which is formed by the lateral surface of the radius articulating internally with the lesser sigmoid cavity of the ulna and is concerned in the movements of pronation and supination of the forearm.

The movements of the elbow are those of a true hinge joint, namely flexion and extension. These movements are oblique so that the forearm is inclined medially in flexion, laterally in extension. The movements are limited by the contact, respectively, of the coronoid and olecranon processes of the ulna with their corresponding fossæ and the humerus, the extent of the movement is determined by the relative proportion between the length of the processes and the depth of the fossæ which receive them, rather than by the tension of the ligaments, or the bulk of the soft tissue parts over

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them. Thus the anterior and posterior portions of the capsule together with the posterior portion of the lateral ligaments are not put on the stretch during flexion and extension, and although they may assist in checking the velocity and prevent undue force and



FIG 10—(Case V) Mrs C, Bryn Mawr Hospital, December, 1933, fracture of capitellum and internal condyle

impact, they do not control or determine the extent of these movements. The limit of extension is reached when the ulna is nearly in a straight line with the humerus (180°), the limit of flexion when the ulna describes an angle of from 30° to 40° with the humerus



FIG 11—(Case V) Photograph of fragment of bone removed. Articular surface on the left, fracture surface on the right

PATHOLOGY—Fracture of the capitellum of the humerus is essentially intra-articular since the epicondyle is not involved. Kocher³ and Lorenz⁵ pointed out that there are two distinct types of this fracture, the Hahn-Steinthal,² or complete fracture of the capitellum, and the Kocher-Lorenz, or partial or peeling fracture of the capitellum

SYNOPSIS OF CASES FOUND RECORDED IN THE LITERATURE

Author	Age	Sex	Etiology of Injury	Crepitus	Position of Displaced Fragment	Degree Dysfunction Due to Injury	Degree of Pronation and Supination	X-ray Report	Treatment Operative or Other	Result and End result
Hahn 1883	63	F	Drunk on Unknown	Present	Upward and anterior displacement	No report	Normal	None	Autopsy	Poor—autopsy
Kocher 1896		M	Fell on extended left hand	Present	Posterior to head of radius	Flexion to 55° Extension to 135°	Normal	None	Removal	Practically normal
	19	M	Carrying heavy weight with extended arm in act of putting weight down, felt snap in elbow	Present	Posterior displacement	Flexion normal Extension to 173°	Normal	None	Removal	Practically normal
	17	M	While riding horse elbow was caught between high wall and side of horse	Absent	Posterior displacement	Flexion normal Extension 135°	Normal	None	Removal	Practically normal
	14	M	Lifting wheelbarrow when snap was heard in elbow	Absent	Posterior displacement	Flexion 50° Extension 115°	Normal	None	Removal	Practically normal
Stenhal 1898	20	M	Fell, striking right elbow in flexion	Present	Anterior and upward displacement	Flexion 35° Extension 145°	No report	Positive	Removal	Flexion 90° Extension 160°
Siebbin 1879	24	F	Fell on extended hand	Present	Posterior to head of radius	No report	No report	Positive with fracture of external condyle	No report	No report
Cotton	40	F	Fell six steps striking left elbow directly	Present	No report	Flexion 90° Extension 130°	Much limited	Positive	Refused operation	No report
Lorenz 1905	20	M	With heavy hammer in act of striking	Present	Posterior displacement	Flexion 135° Extension 150°	Normal	Positive	Removal	Normal Complete restoration of function
	22	M	With iron rod in hand, striking in unwill	Present	Posterior displacement	Flexion normal Extension 90°	Normal	Positive	Removal	Normal
Stimson	Adult	M	Falling stone struck elbow directly	No report	No report	Suppurative joint ankylosis complete	No mention	No mention	Joint excised because of suppuration	No report
	Adult	M	Arm caught between tugboat and float	No report	Posterior displacement	No report	No report	Positive	Fragment sutured back in place	Good
	12	M	Fell in street car with arm beneath hum	No report	Anterior displacement	90° to full extension	No report	Positive	Removal of portion of fragment	Good
Jopson 1913	38	M	Running across street, struck himself on left elbow	Present on supination and pronation	Anterior and upward displacement, articulating surface, points upward	No mention due to extreme pain	Limited much due to pain	Positive	Removal of detached fragment Portion attached was left in tract	Normal to extension 165°
Reinking 1909	9	M	Fell from wagon, striking left elbow	No report	Posterior displacement	Flexion 45° Extension 110°	Pro normal Sup 1/2 "	Positive	Replaced fragment	Normal to extension 170°

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Wright	12	M	Fell on 1 left flexed elbow	No report	No report	Arc of 40°	Normal	No report	Because of suppurative joint, joint was excised	No report
Patterson 1929	25	F	Fell on outstretched left hand	No report	Anterior displacement	Elbow locked at 135°	No mention	Positive	Removal	Flexion 40° Extension 140°
Thnt 1908	40	M	Fell 12 ft on the elbow	No report	Anterior displacement Fragment upside down	Flexion 90° Extension 95°	No report	Positive	Removal	Flexion 45° Extension 170°
Del Bracto 1929	46	F	Fell from ladder Position of arm not remembered	Absent	Posterior and lateral displacement	Flexion 60° Extension 145°	No report	Positive	Arm placed at right angles for 30 days	Result poor
Ciacca 1928	51	F	Fell on left knee and elbow	Present	Anterior and upward displacement	Extension to 150°	No report	Positive	Removal	Good
	17	M	Fell on left elbow	No report	Anterior and upward displacement	Flexion 70° Extension 120°	No report	Positive	Removal	Good
	40	F	Fell downstairs, striking left elbow	No report	Anterior and upward displacement	Extension to 150°	No report	Positive	Removal	Good
Von Saar 1912		M	Driving horse, with arm flexed acutely Holding reins tightly, felt sudden severe pain in right elbow	Present	No report	Unable to flex to right angle	No report	Positive	Removal	Good
		M	While lifting heavy rock, felt severe pain and heard crackle in elbow	Present	No report	No report	No report	Positive	Removal	Good
Billet 1921	22	M	Soldier stumbled against step Fell ventrally on abdomen and left elbow struck directly on ground Did not fall on hand	Present	No report	Unable to flex arm to right angle	No report	Positive	Removal	Normal function
	14	F	Girl, sweeping carpet, fell on left elbow, did not fall on hand	No report	No report	Stiff elbow	No report	Trochlea also involved	Removal	Flexion normal Extension slight
Gay Bonnet 1924	20	M	Soldier fell from top of wagon on the left elbow	Present	Anterior and upward displacement Rough surface facing forward and up	Flexed to 90°	Pronation painful Supination limited	Positive	Removal 2 operations Capitellum in 2 fragments	Flexion 90° Extension 160°
	20	M	Soldier fell from wagon on right elbow	No report	No report	Flexion 130° Extension 160°	Pronation good Supination incomplete	Positive	Removal	Normal
Lee and Summey 1930	7	M	Fell 3 ft to floor on left elbow	No report	Anterior and upward displacement	Flexion 45° Extension 145°	Limitation of both	Positive	Removal	Entirely normal in all movements
Lee 1924	18	F	Fell down steps on left elbow	Absent	Anterior and downward displacement	50% of normal	Limitation	Positive	Removal	Entirely normal
Summey 1931	70	F	Fell in street on elbow	No report	Anterior and upward displacement	Flexion 60° Extension 140°	50% normal	Positive	Operation refused because of age	50% normal
	8	F	Fell on elbow	No report	Anterior displacement	50% normal	50% normal	Positive	Operation refused	Signed release Result unknown
1934	62	F	Fell on elbow	Present	Anterior displacement	Normal	50% normal	Positive	Removal	Normal

The more common type, first described by Hahn and Steintal, is the complete or total fracture, where the fragment is formed of the capitellum together with a part, more or less extensive, of the external lip of the trochlea, is produced most often by a direct blow, such as a fall upon the elbow. When the elbow-joint is in the position of semi-flexion and semi-pronation, the lateral surface of the capitellum is fully exposed for such a direct blow. Twenty-two of the thirty-two cases reported were injured in this way. Another manner in which this dorsal fracture could be produced would be a fall upon the outstretched hand. In this type of fall the force is transmitted chiefly through the radius as the ulna does not articulate with the carpal bones. From the radius the force is transmitted to the external condyle of the humerus through the head of the radius which impinges upon the capitellum. While falls upon the hand frequently produce a transverse fracture above the condyle, sometimes a fracture of the external condyle alone and also fractures of the head of the radius, they rarely produce a fracture of the internal condyle and very rarely a fracture of the capitellum. Only three of the thirty-two cases reviewed were produced in this way.

The second or Kocher-Lorenz type of fracture is much rarer and partakes of the nature of a partial or complete avulsion of the cartilage covering the capitellum, to which small portions of the bony substance may still be adherent to the fragment, and, this fragment being very small, may remain attached to the humerus by means of periosteal fibres. If free, it is usually displaced in the posterior position of the joint between the head of the radius, the olecranon process and the lateral condyle. These partial fractures are usually due to indirect violence and may be produced by the mechanisms of pulling, lifting or hammering. Kocher tries to point out that they are probably caused by traction through the anterior capsular attachments passing backward on the capsule and prying it off, as when the injury occurs while lifting with the forearm extended. Lorenz and Flint¹⁰ do not accept this explanation and Flint claims that this classification does not cover all the types of fractures of the capitellum, and that a further classification for such a small lesion is confusing rather than helpful. Six of the fractures in this series of thirty-three were of this nature.

Diagnosis—The usual immediate clinical symptoms of a fracture, such as swelling, pain, localized tenderness of the part, dysfunction and crepitus, may all be present in fractures of the capitellum.

In this series of thirty-three cases we found recorded definite crepitus in fifteen cases, no crepitus in four, while in fourteen cases no mention was made of it. Crepitus, therefore, would not appear to be a constant clinical finding, probably due to the small size of the structure involved. Several points in differential diagnosis may here be considered. We know that whether it be a total or a partial fracture of the capitellum as differentiated by Kocher and Lorenz, it is always an intra-articular fracture of the elbow-joint, that is, it is always within the capsule joint. The fragment, therefore, acts as a foreign body within the joint. Thus the physical findings are those expected of a loose body within the joint. The degree of dysfunction of the elbow-joint in this series ranged all the way from complete ankylosis to all types of limited motion.

A fractured capitellum, it will be seen, is not a fracture of the external condyle of the humerus, therefore the external relations of the elbow are found to be normal, which constitutes a differential point in diagnosis.

As to displacement of the fragments, in eight of the cases no mention is made, ten had a posterior displacement, and fifteen had an anterior displace-

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ment of the fragments. In discussing the anatomy of the joint, we stated that the radial fossa on the front of the humerus received the anterior edge of the radius in the position of complete flexion of the forearm. Therefore, when the capitellum is completely separated and displaced anteriorly, it obstructs normal flexion by incarcerating itself between the radial fossa and the anterior edge of the head of the radius, and thus the most common disability is obstruction to the normal limits of flexion.

Should the capitellum be displaced posteriorly, extension would be limited, but to a lesser degree, for the displaced capitellum would be interposed between the posterior ligament of the capsule and the radial head, and, because of the pain following the stretching of the ligaments, the extension is limited by pain instead of bony fixation as in flexion.

Again, as the movements of the elbow-joint are those of a true hinge joint, the ulna articulating in perfect apposition with the trochlea of the humerus, the elbow-joint, unlike the knee-joint, depends for its security, strength and path of direction chiefly upon the configuration of its bones and especially the articulation between the ulna and the trochlea. This articulation may be singled out as a director of the elbow-joint. In flexion and extension, the cup-like depression of the radial head glides upon the capitellum and the medial margin of the radial head travels in the groove between the capitellum and the trochlea. This allows the radius to rotate upon the humerus while following the ulna in all its movements. In full extension, the head of the radius is barely in contact with the inferior surface of the capitellum and projects so far backward that its margin can be felt as a prominence at the back of the elbow. In full flexion, the anterior edge of the radial head is received into and checked against the depression above the capitellum, while in mid-flexion the cup-like depression is barely received upon the capitellum, and the radius being more completely steadied by the humerus in this position than in any other, pronation and supination take place most perfectly. Therefore, the articulation of the head of the radius with the capitellum is not necessary for the path of direction, in flexion or extension. If the radius were absent the hinge-like motion of the ulno-humeral joint would still be preserved. Thus the stability of the elbow-joint is not impaired in fractures of the capitellum.

Besides the hinge movements, it will be remembered there is also present within the capsule of the elbow-joint the proximal radial-ulna articulation allowing the mechanism of supination and pronation. It is readily seen that, although in injuries of the capitellum this articulation is rarely interfered with, the dislocation or interposition of the fragment of the capitellum usually does interfere with pronation and supination. In this series of thirty-two cases, in only eight were supination and pronation unaffected. In the rest of them the motion was limited by both pain and ankylosis in the old lesions.

TREATMENT—Since it is true that the ulno-humeral joint is the main joint of the elbow and that, if the radius were absent, the hinge-like movement

would still be preserved, we can see that the danger of a fracture of the capitellum lies in its ability, as a foreign body to act as a mechanical block limiting extension and flexion and also supination and pronation. In but two of the cases was an attempt made to replace the fragment of the capitellum, and one of them that was dressed in a right angle splint had a very poor result. Three who refused operation had poor results. Two other cases had the joint excised because of suppuration, and they must, of course, be counted as poor results. Of the twenty-two cases where surgical intervention was used and the fragment removed, all had good or entirely normal function following. Surgical removal of the fragment, therefore, seems to offer at present the most definite promise of a good functional result in fractures of the capitellum, unless the lesion is recognized very early and replaced immediately.

Summary—Fracture of the capitellum, while apparently an unusual lesion, should be considered as a possibility in all injuries of the elbow-joint in which there is a history of direct violence upon the external condyle of the humerus, or of a force transmitted through the radius from the hand. Surgery is the only treatment that offers satisfactory functional results.

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COLLES' FRACTURE OF THE RADIUS

OBSERVATIONS ON 188 CASES

BY KENNETH M. LEWIS, M.D.

OF NEW YORK, N. Y.

FROM THE FOURTH SURGICAL DIVISION OF BELLEVUE HOSPITAL

FROM February, 1927, to September, 1932, 188 cases of Colles' fracture have been observed and treated on the Fourth Surgical Division of Bellevue Hospital. It has been the custom to follow this type of case in our divisional fracture clinic rather than in the regular out-patient department, so that when the case leaves the ward he remains under the observation of the surgeon originally attending him. In this way, the surgeon in charge of the fracture has the opportunity of caring for his patient from the time of admission to the hospital to the point of ultimate end-result. Of the total number of Colles' fractures which were admitted to our wards we were able to follow 128 cases, or 68 per cent. The remaining patients after returning home were either cared for by their private physicians or, in compensation cases, were taken over by the various insurance companies.

By the term Colles' fracture is meant a fracture of the lower end of the radius, within one and a half inches of the carpal joint surface, either with or without an accompanying fracture of the ulnar styloid. Impaction may or may not be present to a definite degree, though, if present, may result in a shortening of the radius with an accompanying undue prominence of the lower end of the ulna. The usual deformity is the characteristic silver-fork type, due to a posterior displacement of the lower fragment. The so-called reverse Colles' fracture is occasionally seen, in which the lower fragment of the radius is displaced anteriorly. This fracture is always caused by direct violence, usually from a fall on the outstretched hand.

Since the proper time to reduce any fracture is as soon as the patient is seen, as soon as the patient is admitted to the hospital, X-rays of the wrist, in both antero-posterior and lateral views, are taken and the interne on duty then notifies the visiting surgeon on call. The X-rays and the patient are then seen by the visiting surgeon and, if a reduction of the fracture is indicated, it is proceeded with at once. No case coming into the hospital in the evening is allowed to go unmedicated until the following day.

Gas-oxygen is our anæsthetic of choice. Ether is practically never necessary, as the total time of anæsthesia required is always short. The use of 1 or 2 per cent novocaine solution injected about the site of fracture as a local anæsthetic has been advocated quite enthusiastically by some observers. We have used it in twelve instances with very satisfactory results. There is, however, a potential danger in its use, due to the possibility of introducing infection into the site of fracture. Although this possibility is remote if adequate precautions are observed, the use of gas-oxygen is so eminently

COLLES FRACTURE OF RADIUS

satisfactory that there is no reason for using any other form of anæsthesia when it is available

As soon as the patient is anæsthetized closed reduction of the fracture is accomplished. If any impaction is present it is completely broken up before reducing the lower fragment. When reduction is obtained we immobilize the wrist and forearm with the hand in a position of moderate palmar flexion and ulnar deviation. The forearm should be in a position of mid-supination. For immobilization we use anterior and posterior moulded splints, extending from the metacarpo-phalangeal joints to a point just below the elbow. It is important that the splints should not include the fingers, because of the likelihood of resulting stiffness therein. We insist upon active motion of the fingers beginning as soon as the patient has recovered from the anæsthesia and continuing throughout the period of immobilization.

As soon as the effect of the anæsthesia has worn off post-reduction X-rays are taken. If these show that a satisfactory reduction has been obtained the patient is discharged from the hospital with instructions to return to the divisional fracture clinic the following week. All patients however are kept in the hospital for at least twenty-four hours following reduction so that any signs of constriction due to a tight application of the moulded plaster splints may be observed and corrected if present. If the original reduction is not satisfactory, a second attempt is made at once to improve the position. Fortunately this is seldom necessary particularly if the first reduction is done shortly after the fracture has occurred and before swelling of the soft parts has taken place.

A certain number of cases do not require reduction. In these there exists only a simple crack through the bone with no displacement of the lower fragment, no impaction and no tilting of the joint surface. Here simple immobilization is all that is required.

There is a group of cases however to which I wish to call attention. This group is composed of cases in which there is no posterior displacement of the lower fragment but in which there is a greater or lesser degree of impaction with a resulting shortening of the radius. I have frequently seen such a case treated by simple immobilization without any attempt at breaking up the impaction and trying to restore the normal length to the radius. We feel that this is a mistake. All of these cases should be anæsthetized, the impaction broken up and an attempt made to restore the normal length to the radius. If this is not done it leaves the patient with a marked prominence of the lower end of the ulna and also with a prolonged period of disability due to recurring attacks of pain in the injured wrist.

Another group of cases in which reduction is frequently overlooked and in which it should always be attempted are those in which again there is no gross displacement of the lower fragment but in which there is some posterior tilting of the joint surface of the radius. If this is allowed to go uncorrected, there will be a consequent loss of some degree of flexion at the wrist,

the amount lost depending upon the amount of tilting that has not been corrected

We consider the treatment of epiphyseal separation of the lower end of the radius in children the same as Colles' fracture in the adult and as such it is included in this series. There are sixteen cases of epiphyseal separation included herein.

As for the period of immobilization, we believe in very early motion. Our average time of immobilization is from a week to ten days. At the end of this time the splints are removed and left off, the forearm is placed in a sling and active motion at the wrist, together with soaks in hot water twice a day and gentle massage once a day with olive oil, is begun. After a few days of this routine, the patient is referred to the department of occupational therapy, where suitably graduated exercises are prescribed and supervised. In this way very early persistent active motion in both wrist and fingers is obtained and if suitable reduction of the fracture has been obtained originally, it is not unusual for us to see our cases with complete range of motion at the wrist and in the fingers within four weeks.

We realize that we are somewhat radical in removing all immobilization within ten days. We do not claim that bony union has occurred in this space of time, but the fact is that sufficiently firm fibrous union has occurred, making it extremely difficult to move the lower fragment even at the end of one week. Anyone who has tried to reduce a Colles' fracture at the end of a week or ten days will be impressed by this fact.

I have seen a number of cases in which excellent reduction was obtained but the period of immobilization was continued for three or four weeks, which resulted in the patient's requiring three or four months to obtain anything like satisfactory motion at the wrist. I feel sure that in these cases the long period of disability was due to the wrist having been immobilized longer than was necessary. Occasionally one sees a case in which comminution of the lower fragment has occurred, and here we are inclined to increase the period of immobilization to two or two and a half weeks, but never longer. In any fracture which is near a joint, the sooner immobilization can be dispensed with and persistent active motion insisted upon, the quicker will adequate function be obtained. Muscular atrophy is slight in this space of time. I have seen cases in which splints have been left on for six to eight weeks and even with good reduction some of these cases never obtain satisfactory function.

I do not wish to appear too dogmatic relative to the above. It is always true that it is the exception that proves the rule, and that occasionally one will see a case in which the lower fragment, following a good reduction and immobilization for a week or ten days, will subsequently slip out of position. This, however, is so infrequent and the results from prolonged immobilization are so unfortunate that we cannot help the conclusion that the great majority of cases will be benefited immeasurably by shortening the usual period of immobilization. Summarizing the after-care, active motion, per-

sistently carried out by the patient, is by far the most important. The use of hot-water soaks at home together with light massage with olive oil helps to more quickly limber up the part and relieve the stiffness. Occupational therapy has been found to be of maximum help, particularly in the patient who might be inclined to neglect active motion if left to himself.

It has been our experience that passive motion is of very little value and may do a great deal of harm by causing displacement at the site of fracture and by further traumatizing soft parts that have already been severely traumatized at the time of fracture. With active motion, however, these results cannot ensue, as the patient is constantly guided by the pain element. Then again the muscles profit by active motion.

Occupational therapy has been greatly neglected in most hospitals and its value in the after-treatment of fracture cases of all types cannot be too greatly stressed. We are impressed more and more of its usefulness in restoring function rapidly in fracture patients. Occupational therapy, such as block-printing, wood-working, and certain forms of metal-working, is simply a form of active motion in which the patient's attention is diverted from the injured part and directed towards some product that he is making, and by which, in so doing, he is persistently exercising his injured wrist. Patients are urged to report to the occupational therapy clinic at least three times a week. The work here is divided into hospital treatment and home exercises. All treatments are graduated from light to vigorous exercises and measurements as to progress are made each week. The home exercises are of value in preventing loss of motion during days between hospital visits.

By the simple routine of the procedures used in the occupations employed, excellent results have been obtained. The patients become so interested in the object that they are making that they tend to forget the pain and soreness in the injured wrist.

We have been able to follow 128 patients to the final end-result. Of this number the total period of disability (from the time of injury until the patient was able to return to his or her normal occupation) ranged from three weeks to fourteen weeks. The average period of disability was seven weeks. Of the epiphyseal separations in children, of which there were sixteen, we were able to follow thirteen cases. Here the average period of disability was four weeks. The disability ranged from two weeks to eight weeks. Very notable has been the rapidity with which these children regain a complete range of motion in a very short period of time. There has been no interference with subsequent growth of the radius in any of these cases.

There were seventy-two women and fifty-six men, and the ages according to decades were as follows:

10 to 20	30 patients
20 to 30	13 patients
30 to 40	13 patients
40 to 50	35 patients
50 to 60	25 patients
60 to 70	12 patients

There were no compensation cases in the above group. These always pass into the hands of the insurance companies as soon as the fracture has been reduced and the patient discharged from the hospital ward. I am quite sure that the average period of disability in a group of compensation cases would be considerably longer than it has been in non-compensation cases. It is human nature that it should be. Again we note that where there is a possible lawsuit in the future, in cases where the injury has been caused, for instance, by the patient being struck by an automobile, the patient will complain of pain and disability for a much longer period of time than the average.

In analyzing the end-results we have adopted the following method: (1) Cases in which the end-result is over 90 per cent of normal from both the anatomical and functional standpoints are classed as EXCELLENT, (2) cases in which the end-result (anatomical and functional) is less than 90 per cent but more than 75 per cent are classed as SATISFACTORY, and (3) cases in which the end-result is less than 75 per cent are classed as POOR.

It must be admitted that any method of classifying end-results in fractures is affected to some extent by the accuracy of those estimating the degree of anatomical and functional variation from the normal. We have endeavored to err on the side of the poor rather than the good. For instance, if a patient has normal function in all respects with complete range of motion in the wrist and fingers and normal grasping power and no pain, but presents some abnormal degree of ulnar prominence anatomically, we have classified such a case only as SATISFACTORY, even though from the standpoint of function there is a 100 per cent result.

According to this classification, seventy-two cases or 56 per cent may be classed as EXCELLENT, forty cases or 32 per cent as SATISFACTORY and sixteen cases or 12 per cent as POOR. In other words, 88 per cent of the cases have obtained an end-result which is over 75 per cent of normal, from both the anatomical and functional viewpoints. Of the poor results, the commonest cause has been lack of cooperation on the part of the patient in carrying out the after-treatment. Some of our patients are of a very ignorant type and as long as any pain is present it is very difficult to get them to use active motion at all. We have been very much impressed by the long period of disability in such cases. Occasionally they never obtain good extension and flexion at the wrist. Unsatisfactory reduction has played a part in some of the poor results, but not to a very marked degree. It has been surprising to note the excellent functional results that some of the cases with unsatisfactory reduction have obtained where occupational therapy was started early and conscientiously carried out.

PSEUDO-ARTHROSIS OF THE HIP FOLLOWING ACUTE INFECTION OF THE JOINT

BY WILLIAM J STEWART, M D

OF COLUMBIA, Mo

FROM THE DEPARTMENT OF ORTHOPEDICS OF THE UNIVERSITY OF MISSOURI

THE following case of pseudo-arthritis after infectious arthritis of the hip is reported for two reasons. The first is that it represents one of the unfortunate occurrences associated with the immunization against scarlet fever. The second is that a quite satisfactory result has been obtained in an



FIG 1—Bone shelf formed by head with marked sclerosis of shelf and neck of femur. Definite pseudoarthrosis. Ossification of capsule inferiorly.

unusual manner after such a serious infection, using conservative methods of treatment.

Early in March, 1932, the patient, a fourteen-year-old boy, was given an inoculation against scarlet fever at his school. A few days later he complained of malaise and vague pain in the left hip. Two days after the onset of symptoms, the hip became much more painful, red and swollen and the patient was seriously ill with a high fever (104° – 105°). He was confined to bed at home for the following five months. During this entire time the leg was allowed to assume a position of complete extension at hip and knee.

(180 degrees) and extreme outward rotation with no other treatment. The hip became fixed in this position. Late in August, 1932, the patient started walking on crutches. He presented himself for examination at this clinic September 27, 1932.

Physical examination was essentially negative except for the extreme loss of weight and the condition of the left lower extremity. Wassermann and Kahn tests were negative. The hip was rigid and quite painful, in 180 degrees of extension, with the foot held in outward rotation of 80 degrees. Flexion of about five to ten degrees was present at the hip. Rontgen examination of the hip revealed the result of the infectious process, with mushrooming of the head, homogeneous density of the head, loss of cartilage space, no areas of absorption, and an open epiphyseal line. The rather broad neck was felt to be due to position—external rotation.

Because the head was well defined in the rontgenogram and because some slight motion at the hip was detected, it was felt that complete bony ankylosis of the head had not taken place. Accordingly, daily physical therapy and tank treatments were started.

Motion was gradually improved without exacerbation of the infectious process. Rontgenogram one month later revealed the truth of the condition. Flattening of the head in the acetabulum was demonstrated. The epiphyseal line was even more clearly shown. There was an area of absorption of the neck at the infero-mesial aspect, and there was increased density and bone sclerosis on the epiphyseal side of the line. Fluoroscopic examination confirmed the fact that the motion was originating in the epiphyseal line and that the condition was simply a slipped epiphysis that had not been permitted to unite.

Since motion was the desirable factor, manipulation, active and passive, was continued. Rontgenogram showed increased density of head and neck, pseudo-arthritis through the epiphyseal line and some beginning ossification of the capsule. At this time, flexion of twenty-five degrees, hyperextension of ten degrees and almost complete correction of external rotation had been obtained with very little pain on weight-bearing.

The last rontgen examination, December 22, 1932 (Fig 1), showed still further bone sclerosis of the head, which projects from the ilium like a shelf, definite pseudo-arthritis, ossification of the capsule inferiorly and no areas of absorption in head or neck. Clinically, there is flexion forty degrees, hyperextension ten degrees, rotation thirty degrees, no adduction. Patient can sit almost completely erect in a straight chair, walks with a moderate limp, and has absolutely no pain even after walking a mile and a half. There is still some atrophy of thigh and calf. He wears a Thomas heel and uses a cane on slippery or ice-covered streets. His improvement has been most gratifying and there is every reason to believe that it will progress well beyond the present point.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD APRIL 26 1933

The President, DR JOHN DOUGLAS in the Chair

CONGENITAL CHONDRODYSPLASIA

DR RUSSELL H PATTERSON presented a man aged twenty-one years suffering from unsightly and annoying bony projections of various parts of the body. Those that bother him most are located on the left elbow the right knee and right foot. The head of the left radius protrudes out under the skin being dislocated some two inches. Bony prominences of varying



FIG 1—Hereditary deforming chondrodysplasia involving scaphoid and first metatarsal of the right foot

sizes are felt on the right third finger, left clavicle, left humerus, left radius, left ulna, left fifth metacarpal, left fourth finger, right ilium, right femur, right tibia, right foot medially, left femur, left tibia, right radius. The right forearm measures three-quarters of an inch longer than the left forearm.

Films of the feet show an osteochondroma arising from the proximal half of the first metatarsal on the right (Fig 1). The same process is seen

in the upper third of the left humerus. The cortex is expanded with formation of definite exostosis in the region of the greater tuberosity. The same process is seen in the upper third of the femora. There is some spur formation in the region of the lesser trochanter. There is also a spur formation in the ascending portions of the pubic bones. The same process is seen in the upper and lower thirds of the tibiae and fibulae, and in the lower third of the femora (Fig 3). The spur formation in the lower medial portion of the lower third of the right femur is particularly marked. There is extremely marked deformity of both bones of the forearms (Fig 2). There is a congenital dislocation of the left radius.

On January 18, 1929, the bony prominences causing the most symptoms were removed with sharp chisels so that these bones had somewhat their nor-

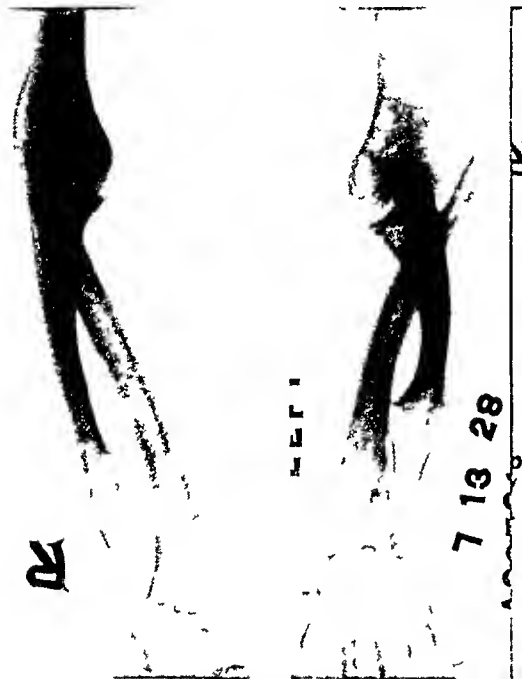


FIG 2—Hereditary deforming chondrodysplasia causing marked deformity of the bones of the forearm. Note the head of the left radius projecting under the skin.



FIG 3—Hereditary deforming chondrodysplasia involving condyles of femora, medial aspects of upper end of tibia and shaft of fibula.

mal alignment. Such bony prominences removed were on the lower third of the right femur medially and the first tarso-metatarsal region of the right foot. Also two inches of the head of the left radius was removed. The cortex of these tumors had either a cartilaginous appearance or a bony appearance. The tumors were filled with cartilage or bony network about which was fat and mucinous-like material. They did not bleed very much. The wounds healed by primary union and convalescence was uneventful.

At the date of presentation, April 26, 1933, more than four years later, the patient is free of symptoms and has not noticed further growth of tumors.

This case is representative of so-called multiple congenital osteochondromata or hereditary deforming chondrodysplasia. It is usually described as congenital but such was not true in this case. The disease is always present very early in life, but is usually not noticed until early adult life. The

SARCOMA OF THE THYROID

increase in symptoms after the bony growths have remained stationary in size for a period of years is suggestive of malignancy. Malignancy occurs in the form of bone sarcoma but such cases are extremely rare. Jeck reported a case in June, 1929, in which there was malignant degeneration of one of these tumors of the pelvis with invasion of the bladder. There is a tendency to bilateral symmetrical involvement. There is a marked distortion of some of the bones during growth, particularly about the ulna and radius. Involvement of almost every bone in the body has been reported, though the skull is usually free. Bones are usually involved about the epiphyseal ends although at times the shaft is also involved. Honeij has reported changes in calcium metabolism. McCallum describes the pathology as follows:

Normal cartilage is not vascular and depends for its nutrition upon the absorption of fluid from the vessels of the perichondrium, no great bulk of it can maintain itself alive. But in cartilaginous tumors the tissue is in small districts and well supplied with nourishment from abundant blood-vessels which accompany its fibrous stroma. Blood-vessels sometimes grow into the cartilage as in normal endochondral ossification and convert it into bone, so that the chondroma eventually becomes a kind of osteoma. Usually a layer of cartilage remains over the surface. The calcification may occur in patches, or softening and cysts may form. The tumors may arise from congenital misplaced cartilage (Vinehow) or from periosteum or endosteum forming cartilage and then bone.

DR FRANK E. ADAIR said that a certain proportion of these cases become malignant and it is difficult to know when this will occur. They are accompanied by sudden growth and in trying to find out if they are malignant it is necessary to make a large section through the periphery toward the base.

SARCOMA OF THE THYROID

DOCTOR PATTERSON presented a man, forty-one years of age, who for eighteen years had had swelling in his neck, which caused no symptoms until the last three months during which time he has felt pressure in his throat, some change in his voice, and slight difficulty in swallowing. He was admitted to Bellevue Hospital March 27, 1933, with a very hard fixed tumor, apparently involving the whole of the thyroid gland, extending across the trachea, averaging some two and one-half inches in breadth. There are no regional palpable nodes. Laryngoscopic examination shows no involvement of the larynx though the trachea is definitely displaced to the right side. X-rays of the lungs showed a deviation of the trachea to the right. Extensive infiltration at the roots of both lungs. Dense fibrosis of the right lower lobe. Moderate interstitial changes and fibrosis in the lower lobe of the left lung. Lower portion of the right thorax is slightly collapsed.

Operation—April 4, 1933, anaesthesia consisted of 75 milligrams of avertin per kilo or 3.8 cubic centimetres, the patient weighing 123 pounds. A small amount of 1 per cent procaine was used as a local infiltration. Usual exposure of the thyroid gland made. A very firm tumor, brittle, very intimately attached to the trachea, extending out through capsule and involving the tape muscles on the left side of the neck. The isthmus was equally as large as the right and left lobes. Small chunks of tissue were enucleated.

There was a grayish watery fluid that could be squeezed from these friable pieces of tumor tissue. Parts of the tumor were broken down into small caseous areas resembling tuberculosis. The tracheal muscles were infiltrated, the infiltration resembling that seen in broken-down lymphatic nodes of the neck. The condition at the time was thought to be of chronic inflammatory nature, perhaps tuberculosis. Four-fifths of the gland and tumor area was removed. There unquestionably was tumor tissue left. The wound was closed in the usual manner with a mid-line drain. The wound healed rapidly.

Temperature after operation went up as high as $103\frac{1}{2}^{\circ}$, pulse 125. Both were normal by the twelfth post-operative day. Reaction after operation was not marked. After the operation the patient was given three drops of Lugol's solution three times a day. On the seventh post-operative day X-ray radiation was begun but infiltration of the neck has progressed rapidly and unfavorably since the operation. The patient cannot swallow as well and his voice is more changed. Symptomatically he is fairly comfortable.

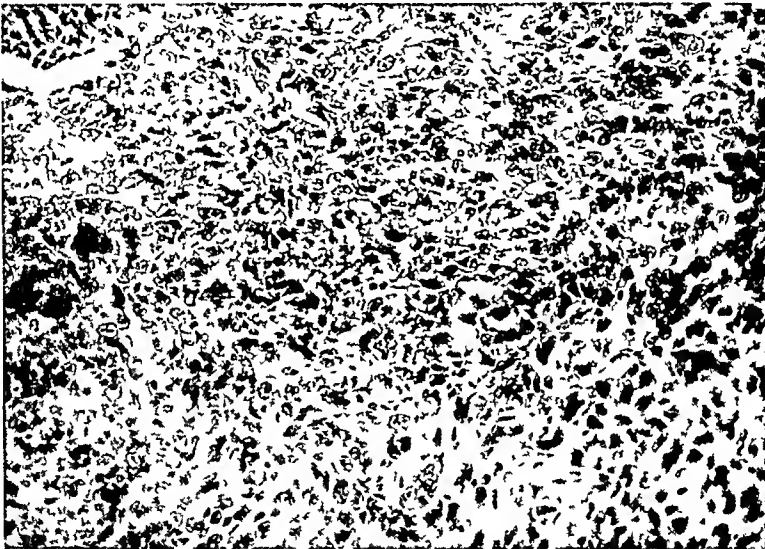


FIG. 4.—Sarcoma of thyroid. Medium power photomicrograph. Note spindle cell arrangement, few giant cells, numerous mitotic figures.

Culture taken from the substance of the tissue showed at the time of operation pure staphylococcus aureus. Histological sections (Fig. 4) have been diagnosed by Dr. Douglas Symmers of Bellevue Hospital as spindle-cell sarcoma. These sections show a very malignant tumor. There are quantities of mitotic figures. There are many scattered giant-cells which may be tumor cells or they may be reaction to the necrosis of the tumor, foreign body giant-cells. The type cell is a spindle cell. There is a matrix instead of a stroma indicating that the tumor is of the connective-tissue origin.

Proved cases of sarcoma of the thyroid gland are exceedingly rare, and the diagnosis in this case seems to be fairly certain. There are only two other cases (1917 and 1923) reported in the pathological files of Bellevue Hospital. There are forty-six cases of carcinoma recorded.

DR. ARTHUR S. McQUILLAN considered that this case illustrated very well several features which other observers have noted about these tumors. Their rarity is noteworthy and no doubt even more than present accounts

ANTERIOR DISLOCATION KNEE-JOINT

indicate if the theory is true that sarcomata have true origin in the thyroid gland are yet to be seen, these so-called thyroid sarcomata being invasions or metastases from extrinsic sources. Doctor Ewing and his co-workers at the General Memorial Hospital are inclined to believe that true thyroid sarcomata do not exist.

The single case of sarcoma in Doctor McQuillan's series, one of the three mentioned by Doctor Patterson at Bellevue Hospital, would seem in a way to bear out this theory, for in this case the tumor involved the right lateral neck structures as well as the thyroid gland. Doctor Rogers recently encountered an only case in his series. This was missed at the time of operation when the clinical and pathological diagnosis of the thyroid tumor was thyroid adenoma. It was only when the patient returned three months later with liver and inguinal lymph-node involvement that the original diagnosis was corrected, as reexamination of the thyroid tumor revealed a small area of sarcoma. It is not impossible for this to have been an invasion or a metastasis since sarcomata usually invade through the blood-stream, so great is the vascular avenue of approach to the thyroid gland, so frequently does the blood filter through this gland.

However many observers believe in the true thyroid origin of sarcomata, there is still much confusion regarding the classification of these tumors. Pathologists talk about small round-cell carcinoma, giant-cell carcinoma and sarco-carcinoma. These terms are confusing and one is inclined to agree with Doctor Graham, of the Cleveland Clinic, who attaches more significance to the clinical course and behavior of these malignant tumors of the thyroid than to their microscopical structural appearance.

Doctor Patterson had emphasized the high basal metabolic rate, and symptoms of hyperthyroidism. These have been frequently noted by other observers as well as a rise in temperature.

As demonstrated by Doctor Patterson's case and others these sarcomata of the thyroid are engrafted upon a long-standing adenoma and occur in middle and late life. This is at variance with sarcomata occurring elsewhere. All agree that these tumors are fast-growing, invariably fatal and the cures by surgery are purely accidental.

ANTERIOR DISLOCATION KNEE-JOINT

DOCTOR PATTERSON presented a man, forty-six years of age, who was admitted to Bellevue Hospital March 13, 1933. On the day of admission he had fallen down ten steps in a subway station injuring his left knee. He was a large, healthy, strong man. His left knee was painful, swollen, and there was marked relaxation of the quadriceps. The bony condyles of the femur could be felt low in the popliteal space. The left foot was inverted. X-rays showed a marked dislocation at the left knee-joint. The condyles of the femur were in the popliteal space behind the head of the tibia (Fig. 5).

Under gas-oxygen anaesthesia the left thigh was flexed to a right angle. A sheet was placed around it and tied to the head of the bed. Traction was then applied to the left foot, pulling the tibia forward and downward (in

flexion) off the anterior surface of the condyles of the left femur. The left lower extremity was put in a Thomas splint with slight skin traction. Eight hours later a circular plaster-of-Paris bandage was applied from the left groin down including the left foot, the knee being flexed some fifteen degrees. At the end of three weeks the plaster-of-Paris bandage was removed. The left knee was found to be one and one-half inches larger than the right knee. There was a complete toe-drop. Patient was fitted with a Thomas ambulatory splint and physical therapy was begun. Four months after the accident the patient could flex the knee to a right angle. Complete extension was possible but the toe-drop had not improved. There was no abnormal lateral mobility



FIG. 5—Complete anterior dislocation of left knee joint. Lateral view.

present in the left knee. A neurological note of November 6, 1930, one and one-half years after the accident, was as follows:

This patient had a mild residual left foot drop and sensory hyperesthesia. Improving in the last one and one-half years. Believe it was a case of pressure neuritis of the left perineal with the result of palsy. Do not think nerve was severed. No atrophy and extent of sensory change is against this.

About the same condition of the foot exists today. There is normal flexion of the knee-joint, no abnormal lateral motion, extension normal, excellent function—no brace.

This condition is a very uncommon accident, being the only one the speaker knew of on the Cornell division at Bellevue Hospital during his thir-

teen years' service The condition has always attracted the attention of the medical profession Astley Cooper in 1832 described two cases of dislocation of the knee—one was in the year 1802 and the other in 1806 The dislocations are divided according to the direction in which the tibia is displaced The anterior dislocations constitute about half of those recorded The injury most often occurs by hyperextension of the knee Stimson speaks of three cases where both knees were dislocated Several of the old books speak of amputations necessitated by injury to the popliteal vessels

In this case the crucial ligaments must have been completely divided and the posterior ligaments of the knee-joint were probably detached along with the periosteum—somewhat as if one had performed a posterior capsulotomy—yet the stability in the knee is remarkable

DR JOHN J MOORHEAD said that complete dislocations of the anterior form are rare with no resultant damage to the crucial ligaments Apparently the effects of crucial ligament injury has been overstressed in respect to knee-joint trauma In most of the cases definite evidence of crucial injury is lacking The secret of success in the management of this case was the promptness with which reduction was accomplished

EPITHELIOMA OF LEG

DR JOHN H GARLOCK presented a man, fifty-eight years of age, who was admitted to the second surgical division of the New York Hospital September 29, 1931, with the following history

Two and a half years before, he accidentally bumped the left shin against an object The leg became swollen and discolored The injury finally healed, after the application of numerous home remedies, leaving a noticeable thickening of the skin over the front of the upper leg About one month later, a warty excrescence appeared in the centre of the thickened skin This the patient removed himself with a knife Bleeding was profuse following this operation The resulting wound failed to heal and grew slowly larger and larger during the following two and a half years For four or five weeks before admission to the hospital, the tumor mass had grown quite rapidly (Fig 1)

Examination showed a large, irregular, oval cauliflower, fungating surface tumor situated just below the left knee on the anterior aspect of the leg It measured seven by ten centimetres The surrounding skin was thin, shiny, and discolored The lesion itself was tender to touch and was covered with foul-smelling discharge It was freely mobile on the deeper structures, except over the region of the tibial tubercle, to which it seemed firmly attached Three small nodes were felt in the left groin The rest of the examination was negative The liver was not enlarged, and the chest was clear X-rays of the various long bones were negative, except for the left tibia, which showed an irregularity at the level of the tibial tubercle The Kline test was four plus A biopsy taken from the edge of the lesion, on October 1, disclosed a squamous-celled carcinoma October 3 the lymph-nodes were removed from the left groin, which, upon pathological examination, failed to disclose metastases

The surface of the tumor was cleansed with daily dressings of Dakin solution October 15 the entire mass was excised with the electric cutting knife The lesion was outlined by an incision three-quarters of an inch away from

its edge. It was found to be intimately adherent to the tibial tubercle. The latter structure was removed with the growth in one piece. The resulting defect was treated subsequently by the Carrel-Dakin method and was covered by a pedicled flap swing from the opposite thigh (Fig 2). The graft took without incident, and all wounds healed rapidly (Fig 3). The patient was discharged January 27, 1932. He has been well ever since. There is no evidence of a recurrence. The skin over the front of the knee is soft and pliable, and motion in the knee-joint is normal.

This patient is presented because of the enormous size of the epithelioma and its attachment to the tibia. The speaker called attention to the value of pedicled flaps in covering defects over parts of the body exposed to con-



FIG 1—Appearance of lesion upon admission to hospital

stant trauma, and needing a covering of greater thickness and durability than can be offered by the use of Thiersch or split-thickness grafts.

DR GEORGE H SEMKEN stated that Doctor Garlock's case could be discussed from two standpoints—one, that of the carcinoma, the other, that of the reparative procedure.

It is not probable that the trauma directly caused the carcinoma, but this patient probably had an unnoticed epithelial papilloma at that site, which was stimulated to a more active growth by the trauma and became the prominent wart. This, in turn, became more intensively activated in growth by the knife-cut made by the patient, and somewhere in this course, the carcinomatous addition occurred.

EPITHELIOMA OF LEG

The regional lymph-nodes in this instance were removed as the first step in the procedure and the primary cancer was excised at a later date. From the cancer view point this order should have been reversed. Since it is understood that cancer cells from the primary tumor find their way via the lymphatic vessels into the lymph-nodes the primary removal of the lymph-nodes alone leaves a cavity with a raw surface into which the lymphatic vessels discharge lymph that may contain cancer cells. Cancer implantation is thus produced on an ideal surface for a cancer graft. It is safer, therefore to defer the removal of the regional lymph-nodes until after the excision of the primary



FIG 2

FIG 3

FIG 2—Method of "waltzing" flap from anterior aspect of right thigh to point of attachment on the inner side of left thigh, preparatory to covering of defect in front of knee

FIG 3—Photograph of end result two years after operation. Scar marking the donor site of the tubed flap which covered the defect is indicated

cancer so that it is the last step of one operation or is done at a later date. The removal of the lymph-nodes at a later date has the advantage of giving the lymphatic vessels (at least theoretically) time to discharge the contained cancer cells, if any into the lymph-nodes, and tends thus to increase the certainty of the cancer removal.

Doctor Garlock's method of repairing the large defect on the leg with a tubular skin flap transplant from the other thigh has been ingenious and successful but it has necessitated a long period of treatment. It is simpler, in these cases to do the cancer excision and the reparative procedure at one operation. As the first step the ulcerated cancer surface is lightly cauterized to prevent viable cancer cells from being rubbed off and reimplanted in the

wound during the excision. The cancer is then removed by the usual method of surgical excision rather than with the endotherm knife, and the resultant defect is covered with a sliding flap taken from the adjacent region. In cases like the present one, this flap could be taken from the inner surface of the leg, with the pedicle at the knee. If the area of excision is too wide to be covered by the available flap, the flap is laid across the area of greatest motion or stress, and the remaining raw surfaces above or below the flap are covered with an immediate Thiersch graft. The defect at the site from which the flap was taken is narrowed with sutures about the margin, and the remaining raw surface is covered with a primary Thiersch graft also. The after-care is simple and the period of hospitalization is short.

RECONSTRUCTION OF LOWER LIP, CHIN AND NECK FOR BURN CONTRACTURE

DOCTOR GARLOCK presented a girl of fourteen, who was admitted to the second surgical division of the New York Hospital July 28, 1931.

At the age of eight she sustained severe burns due to hot water, involving the neck, chest, and left axilla. The burns healed, and produced a severe contracture, involving especially the neck and lower lip. Six months later, an attempt was made to correct this contracture, but the result was unsatisfactory. The patient, although fourteen years of age, has the mentality of of six- or seven-year-old child. Because of this, the procedures that were contemplated had to take into consideration the fact that there would be no co-operation on the part of the patient.

Examination showed a cicatricial contraction of the neck, more marked on the left side, resulting in a marked ectropion of the lower lip with constant drooling of saliva (Fig 4). The skin on the back was scarred superficially in various regions.

July 30, 1931, a flap of skin measuring ten by three inches, was outlined on the back, extending from the mid-line opposite the first thoracic vertebra downwards and to the left. This was fashioned into a tube. The remaining skin edges on the chest wall were undermined and approximated beneath the flap. These wounds healed by primary union, and the patient was discharged from the hospital.

The second stage was performed October 24, 1931 (Fig 5). An area measuring five by three and one-half inches, was marked out on the chest wall, extending from the distal extremity of the original tubed flap but remaining attached to it. This flap was lifted from the underlying muscle and was immediately replaced and sutured in its original bed. The purpose of this procedure was to permit an adequate blood supply through the tubed flap before complete separation from the chest wall.

The next operation was done November 4, 1931. The rectangular flap was again lifted from the chest wall, and was extended distally for another inch and a half. The incision was then rounded for an inch and a half on each side, thus beginning the cutting through of the last attachment to the chest wall. The flap was separated off from the underlying chest wall all around except for the attachment of an area about two and a half inches in length. After control of bleeding, the flap was replaced in its bed and sutured.

November 16, 1931, the fourth stage was performed. The previously outlined rectangular flap was dissected free from the underlying structures on all sides, and separated free from the chest wall. Its nutrition was excellent.

RECONSTRUCTION FOR BURN CONTRACTURE

and actively bleeding vessels were found down to its distal end. The remaining raw area on the chest wall was covered with Thiersch grafts taken from both thighs. The patient was then turned about. The contracting scar on the left side of the neck was excised from the anterior border of the trapezius muscle to the mid-line of the neck and from the ramus of the mandible down to the clavicle. This defect corresponded to the size of the skin flap at the end of the tubed flap. The flap was then laid into the defect and sutured into place. Dead space was obliterated by placing interrupted sutures of plain catgut between the under surface of the flap and the neck wound. A zero-form ointment dressing and pressure bandage were applied. The part was immobilized in a plaster case which included the head, neck, and thorax with



FIG 4—Appearance of patient before operative correction



FIG 5—Photograph of patient after second operation. Tubed flap has been raised. The second operation consisted of the raising of a quadrilateral flap as indicated in the photograph.

both arms by the side. In order to prevent any form of pressure on the tubed flap, a specially devised cradle was placed over it underneath the plaster cast. The flap healed by primary union and the cast was removed on the twelfth post-operative day. The patient was discharged from the hospital.

She was readmitted April 7, 1932. On April 25, the fifth stage was done (Fig 6). In order to correct a contracture which was taking place in the mid-line of the neck, a "Z" plastic was done at this site. This immediately eliminated the vertical scar in the middle of the neck and permitted complete extension of the head. At the same time the posterior extremity of the original tubed flap was cut across transversely. The tube was opened along its original suture line posteriorly for half the length of the tube. This formed a flat piece of skin and subcutaneous tissues measuring about one

and three-quarter inches transversely, and two and a half inches longitudinally. The blood supply was excellent. The scar along the left side of the lower lip and chin was then excised so as to correct the ectropion of the lip. The opened-up part of the tubed flap was then laid into this defect and sutured into place. Zetiform ointment pressure dressing was then applied. The head, deviated slight to the left, and neck, were then immobilized in a plaster case.

Another stage in the plastic repair was done May 18, 1932. At this time the remaining pedicle of the original tubular flap, which was situated on the lateral aspect of the neck, was divided transversely, and the defect in the neck at this point was closed with horsehair stitches. This part of the tubed flap was then opened up along its original suture line for a distance of about an inch. Excess subcutaneous fat was removed. The scar just below the ver-



FIG 6—Appearance of the patient following the fifth operation. Posterior extremity of the original tubed flap has been divided and this end of the tube inserted into a defect in the chin following excision of more scar.



FIG 7 (Case II)—Photograph of patient about six months after final operation.

million border of the lower lip was then excised, leaving a defect measuring one inch long and one and a half inches wide. The edges of the defect were undermined and the remainder of the flap turned upon itself and inserted into this defect. The size of the flap at this point was somewhat larger than the defect which it covered in order to compensate for expected future contraction. Primary union took place. June 4, 1932, the final operation was performed and consisted in excision of the remainder of the tubed flap and re-adjusting of the remaining wound edges so as to produce an even contour of the chin and adjacent lower lip.

These various procedures have resulted in a well-shaped chin, a straight mouth, and a normal neck outline (Fig 7). The skin is soft and pliable, and resembles closely the texture of the skin of the face and neck.

RECONSTRUCTION FOR BURN CONTRACTURE

DOCTOR GARLOCK presented a second case in the person of a woman, aged thirty-six years, who was first admitted to the second surgical division of the New York Hospital December 13, 1931. Thirty years before, at the age of six, she had been severely burned at an open-grate fire. The burns involved the face, chin, neck and hands. Healing finally took place with deforming scars, resulting in a marked ectropion of the lower lip, scarring of the neck and chin, producing loss of the normal contour of these structures, ectropion of the right upper eyelid which prevented closure of the lids, and an opacity of the right cornea.

When admitted to the hospital there was an absence of the outer three-quarters of the right eyebrow. The right upper eyelid was scarred and contracted to such a degree as to prevent closure of the eyelids. There was a



FIG 8

FIG 9

FIG 8—Appearance of patient before operative correction. There is a dense scar extending from the vermilion border of the lower lip to the manubrium, and involving the chin and neck and lateral aspects of the face. There is a complete ectropion of the lower lip. The ectropion in the right lower lid and the loss of most of the right upper eyebrow is indicated.

FIG 9—Final result after numerous operations described in the text. The transplanted skin is soft and pliable, and the contour of the neck and chin has been restored. The change in the appearance of the right upper eyelid following transplantation of a split thickness skin graft is evident.

small opacity of the cornea. There were thickened pitted scars involving the chin and neck. The lower lip was everted to such an extent as to bring to view the lower teeth and gum. The vermilion border was attached to the border of the chin. There was an absence of the normal contour of the neck and chin due to extensive scarring which also prevented extension of the head (Fig 8).

December 16, 1931, the first stage was performed by the formation of a tube from the skin of the back. The remaining skin edges were undermined and approximated beneath the flap.

April 17, 1932, the second stage was performed, consisting of the outlining of a flap, four by six inches, continuous with the distal extremity of the tubular flap. This was lifted from the chest wall except at its distal at-

tachment. It was then immediately replaced and sutured in its bed. On May 2, 1932, the flap was again raised as at the previous operation, but was extended for another inch and curved around at its distal extremity until it remained attached to the chest wall by one inch of skin and subcutaneous tissue. It was then resutured into its original bed. The object of these two operations was to permit of the formation of an adequate blood supply through the original tubed flap.

May 23, 1932, the fourth-stage operation was performed. The quadrilateral flap which had been lifted on the two previous occasions, and which was continuous with the distal extremity of the original tubed flap, was completely lifted from the chest wall after incision through the original suture line. A considerable amount of subcutaneous fat was removed from its under surface. Viability to this flap seemed excellent, and numerous actively bleeding vessels were found as far as its distal extremity. The defect on the chest wall thus produced was closed by a plastic undermining so as to produce an H-shaped scar. The field of operation was then changed and the patient placed upon her back. The entire scar over the front of the chin below the lip and including a large part of the neck was completely excised. This permitted the lower lip to resume its normal position. All the subcutaneous fat was removed from this area. The defect measured four by six inches. The original tubed flap was swung around the neck, and the quadrilateral flap inserted into the chin and neck defect. Precautions were taken to obliterate dead space, and the skin edges approximated with horsehair stitches. Because of the laxity of the tubed flap, and the excellent cooperation of the patient, no retentive apparatus was necessary. Healing took place by primary union without necrosis of any part of the flap.

June 30, 1932, the proximal attachment of the original tubed flap in the region of the left shoulder was divided. The tube was opened along its original suture line for a third of its distance, and converted into a flat section of skin and subcutaneous tissues. An area of scar tissue was excised from the right side of the chin and adjacent neck. The tubed flap was then turned upon itself and its opened-up distal end was accurately fitted into the newly created defect on the right side of the chin. Healing took place by primary union.

July 19, 1932, the original distal attachment of the tubed graft to the quadrilateral flap was cut across on the left side of the neck. The remaining wound was repaired. This end of the tube was then opened up along its original suture line so as to form a flat piece of skin measuring three by two and a half inches. This was used to replace a scar at the base of the neck which was excised. It was sutured into this newly created defect, and healed by primary union.

August 18, 1932, that part of the tubed flap which was attached to the right side of the chin June 30 was divided. The excess fat was removed and the wound was repaired. The remainder of the tube was then used to fill a defect following excision of a scar marking the distal extremity of the original rectangular flap. All these wounds healed by primary union.

In the following few months, it was noted that a vertical ridge of scar tissue was forming near the centre of the neck preventing full extension of the head and producing a slight ectropion of the right side of the lower lip. To correct this deformity, a "Z" plastic was performed January 8, 1933, with extensive undermining of the two flaps of the "Z". The flaps were transposed and sutured into place with fine horsehair. Primary union resulted. There was no sloughing of the tips of the flaps. The ridged scar was thus completely obliterated.

RECONSTRUCTION FOR BURN CONTRACTURE

February 15, 1933, the entire scar of the right upper eyelid was excised, extending from almost the lid margin to the region of the eyebrow. Scar tissue strands were found extending into the substance of the orbicularis muscle. A split-thickness graft was then taken from the inner side of the left arm and placed over a mold of dental compound. This was sutured in such a way as to evert the upper eyelid. The first dressing was done on the eighth post-operative day, and it was found that the graft had taken completely.

The final operation was performed on March 23, 1933, at which time a full-thickness skin graft taken from the temple region of the scalp was inserted into a defect created in the right eyebrow region in order to replace the lost eyebrow. This graft took without incident.

These various procedures have resulted in a normal contour of the chin



FIG 10—Close up photograph of upper eyelid showing the return of skin wrinkling. The growth of hair in the new eyebrow has not reached its full extent.

and neck, and a reposition of the lower lip to its normal state (Fig 9). The various scars on the chin and neck have been so placed that, should they contract, no deformity will result. The new skin is soft and pliable and approaches the texture and appearance of the skin of the rest of the face. The right upper eyelid is soft and pliable, and of sufficient length to permit closure of the lids. The new eyebrow is growing hair which, in the future, will require trimming (Fig 10).

These two cases were presented to illustrate a method for covering the chin and neck with normal skin for the correction of cicatricial contractures following burns. Of course, numerous operations are necessary, but success is assured with the exercise of care in obtaining adequate blood supply of the various flaps. The full-thickness skin graft can be used to cover such defects, but because of the uneven contour of the area involved and the necessary motion of the cricoid cartilage during the act of deglutition a successful "take" becomes highly problematic. A split-thickness graft can also be used

in this situation, as recently advocated by Blair. However, the 40 to 50 per cent contraction which takes place in these grafts subsequently, and the change in appearance of the grafted skin, are serious objections to its use in this situation.

ACTINOMYCOSIS OF TRANSVERSE MESOCOLON AND GREAT OMENTUM

DOCTOR GARLOCK presented a woman, fifty-seven years of age, who was first seen November 15, 1928, at which time she presented a severe exophthalmic goitre of four years' duration. The basal metabolic rate was +83 per cent. After preliminary preparation with Lugol's solution, rest in bed, *etc.*, a subtotal thyroidectomy was performed December 13, 1928. Following this, she gained thirty pounds in weight and was clinically well. She was seen again October 2, 1929, at which time she complained of indigestion and distress in the lower abdomen, of five weeks' duration. She belched considerably and had lost six pounds in weight. A large mass was detectable in the lower abdomen below the umbilicus, approximately in the mid-line. It was slightly tender, firm, and somewhat movable. The tumor seemed to be connected with the uterus. October 10, 1929, a lower right rectus incision was made.

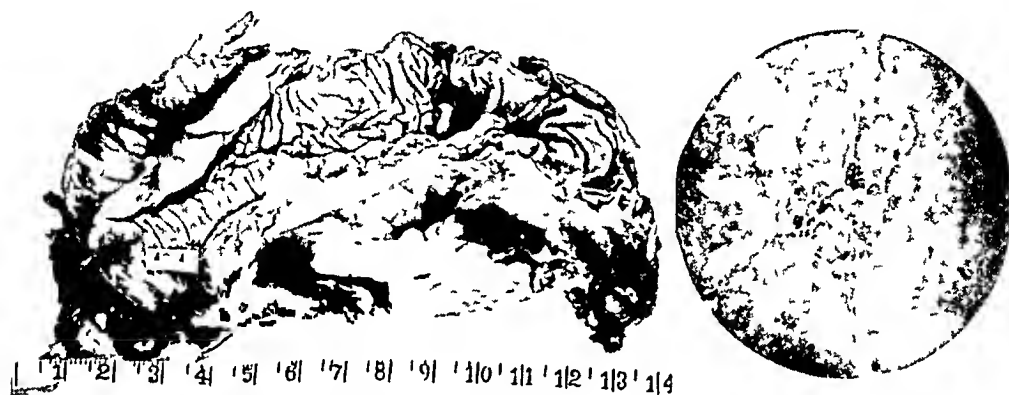


FIG. 11.—Gross and microscopic pictures of excised specimen. The major portion of the pathology was located in the great omentum immediately attached to the transverse colon. Microscopic section shows the characteristic ray fungus.

The tumor was about six inches in diameter and situated in the great omentum immediately attached to the transverse colon (Fig. 11). It was redish-blue in color, and presented a necrotic area on its anterior surface. The parietal peritoneum was markedly thickened for about two inches on each side of the incision. There were no palpably enlarged lymph-nodes and the liver was negative. It was difficult to tell whether the mass arose from the bowel wall or from without the bowel. Under the supposition that the tumor was a carcinoma, the transverse colon was resected. The ends of the divided bowel were inverted and a side-to-side three-layer anastomosis performed. The thickened parietal peritoneum was excised as far as possible and the wound closed after placing two cigarette drains at the lower angle. Pathological report of the excised specimen states that it consisted of transverse colon, seventeen centimetres in length with attached mesocolon and omentum. Colon is normal. The pathology is located in the mesentery. There is a diffuse inflammatory process extending irregularly through the fat in all directions, forming variable sized pockets filled with broken-down tissue. Some of this resembles pus, some necrotic fat. In some, hæmorrhage has occurred. No mesenteric thrombosis could be found. The general appearance is not suggestive of tumor. No communication with the gut is demon-

CARCINOMA OF TONSIL

strable The microscopical examination disclosed the presence of colonies of organisms resembling actinomycosis Following operation, the blood sugar rose to 210 per cent This was controlled with insulin and diet, so that after ten days, the blood sugar was 159 per cent She left the hospital November 1, 1929, with the wound completely healed

She was readmitted to the hospital November 21 1929, with the history that pain had developed in the epigastrium and that she had noted a firm mass in this area Examination revealed the presence of a mass in the right upper quadrant It was somewhat tender and firm, and felt fixed

November 22, 1929, the tumor was exposed by an upper right rectus incision The mass was two inches above the upper limits of the former incision The parietal peritoneum was somewhat thickened and densely adherent to the large bowel In the upper half of the incision the peritoneum was freed and the abdomen was found filled with adhesions Along the course of the falciform ligament near the surface of the liver was situated the mass Gentle manipulation revealed an abscess containing two ounces of thick yellow odorless pus A biopsy was taken from the walls of the abscess cavity and cultures of the pus were made Two cigarette drains were inserted and the wound was closed loosely in layers Pathological examination of the biopsy specimen failed to disclose actinomycosis There was a dense polynuclear leucocytic infiltration The cultures showed no growth

Post-operatively, the wound was irrigated with 25 per cent potassium iodide solution daily 10 cubic centimetres being left in the wound During the patient's stay in the hospital, she received fourteen injections of sodium iodide intravenously, fifteen grains at each dose She was also given large doses of potassium iodide by mouth Following discharge from the hospital twelve more injections of sodium iodide were given A tube was kept in the sinus until the first part of August, 1930 Following its removal, the sinus closed almost overnight In addition, six deep X-ray treatments were administered following her discharge from the hospital

At the present time she is perfectly well, her bowels move regularly, she is doing her regular work, and has gained thirty pounds in weight Examination shows both incisions to be firmly healed There is no palpable mass or thickening anywhere in the abdomen

This case is presented as one of actinomycosis of the transverse mesocolon and great omentum having its origin from the transverse colon The secondary abscess probably was secondary to leakage from the suture line after the intestinal resection The administration of large doses of iodides, both by vein and by mouth, and the course of deep X-ray therapy were probably important factors in the recovery of this patient

CARCINOMA OF TONSIL

DR CARL EGGERS presented a man, fifty-eight years of age who was admitted to the Lenox Hill Hospital, June 6 1929 on account of a swelling in his throat which he had noticed ten days before There had been discomfort but no pain and no difficulty in swallowing

He had complained of dyspnoea on exertion for ten years, precordial pain with radiation into the left arm for three years, and swelling of the feet for several days He weighed 129 pounds and he did not look sick General examination showed moderate hypertension with a blood-pressure of 160/90, slight enlargement of the heart to the left, with a systolic murmur at the apex and base The urine showed a trace of albumen with casts, but the blood chemistry was within normal limits The Wassermann examination was negative X-ray examination of the chest was negative

Locally he presented a hard, nodular tumor about the size of a plum in the right tonsillar fossa. It was apparently strictly limited to the tonsil. It bled easily, and impressed as a malignant growth. There was no gross evidence of metastatic cervical lymph-node involvement.

Under rectal oil-ether anæsthesia the mouth was opened wide with a gag, and with a suture through the tip of the tongue for traction and with long retractors, the tonsil region was well exposed. A silk suture was placed at the commissure above the tonsil for traction, and with a flat electrocautery the entire tumor together with both pillars of the fauces was excised down to the base of the tongue, and the dissection was then continued downward until there was assurance of being well below the lesion, and the entire specimen removed in one piece. The floor of the pharyngeal wound was then again lightly cauterized. There was very little bleeding which was controlled with the cautery and with a few well-placed deep suture ligatures. The convalescence was uneventful. The highest temperature was 101.6° at the end of the second day. He was discharged, cured, on the fourteenth day. There has been no sign of trouble since. The pathological report was Squamous-cell epithelioma of the tonsil.

RETICULUM-CELL SARCOMA OF THE TONSIL AND CERVICAL LYMPH-NODES

DOCTOR EGGERS presented a man, forty-three years of age, who was admitted to the Lenox Hill Hospital, January 30, 1928. A week before a swelling had been noted on his left upper neck, with enlargement of the left tonsil. The tonsil was removed by Dr. John D. Kernan, who did a clean dissection and encountered no unusual difficulty. Pathological examination showed early reticulum-cell sarcoma of the left tonsil and chronic inflammation of the opposite one. Two days after the tonsillectomy he was seen by the reporter. His general condition was good. The tonsillar fossæ were lined with a thick exudate and the tongue was coated. Below the angle of the left jaw, corresponding to the region of the superficial cervical lymph-nodes, there was a deep-seated mass about the size of a walnut, somewhat movable and not tender to touch. There were no skin changes and no fluctuation could be made out. The surrounding lymph-nodes did not seem involved. There was no general lymph-node enlargement. Chest examination was negative, and a roentgen picture showed no involvement of the lungs. Examination of the blood showed no abnormality.

In view of the positive diagnosis of sarcoma of the tonsil a diagnosis of secondary lymph-node involvement was made. Operation was deferred for a week to allow the tonsil fossæ to heal and thereby diminish the possibility of pulmonary infection by aspiration.

Under general inhalation anæsthesia an incision was made along the anterior border of the left sternocleidomastoid muscle from the ear lobule almost down to the clavicle. A transverse incision was added at the level of the hyoid bone, extending forward to the median line. The skin flaps so outlined were dissected back together with the platysma. A radical block dissection of the neck was then done including the submaxillary, the superficial, and the deep cervical regions. The submaxillary salivary gland and the lower pole of the parotid gland were removed together with the tumor and the cervical lymph-nodes. A stab wound was made behind the sternocleidomastoid muscle for the exit of two split-tube drains, and the entire wound then closed. The platysma was sutured with continuous plain catgut and the skin with interrupted silk. Primary union resulted, and the patient was discharged eleven days after operation. While still in the hospital X-ray treatments were

BILATERAL SUBPHRENIC ABSCESS

begun, to include the cervical and thoracic regions, and they were continued after discharge

Pathological examination showed no involvement of the submaxillary or parotid salivary glands. The tumor itself and several of the surrounding lymph-nodes showed reticulum-cell sarcoma. The entire chain of deep posterior cervical lymph-nodes was not involved.

About five months later the patient again noticed a swelling on the left side of the neck. It impressed as an enlarged lymph-node, was about the size of a hazelnut and situated next to the larynx. It was movable and not tender. There was no evidence of recurrence in the mouth or scalp. The node was removed under local anæsthesia together with surrounding fat and connective tissue. It was reported as a hyperplastic lymph-node.

There has been no trouble since.

This case was presented because of the comparative rarity of the tumor and its high degree of malignancy. New and Broders of the Mayo Clinic have made a careful study of tumors of the nasopharynx, pharynx and base of the tongue. The most common are lymphosarcoma and transitional cell carcinoma, with the latter about seven times more common than the former. Eighty-four per cent of all lesions occurred in males. Many of the patients noted enlargement of the cervical lymph-nodes as the first sign of the disease.

These sarcomata of the pharynx are very malignant and are highly radio-sensitive. For this reason some surgeons advise radiotherapy as the method of choice. In operable cases it is advisable to do a radical excision of the primary lesion followed by a block dissection of the neck and subsequent X-ray treatment as was done in this case.

BILATERAL SUBPHRENIC ABSCESS SECONDARY TO PERFORATED GASTRIC ULCER

DR EGGERS presented a man, forty-two years of age, who was admitted to the medical service of the Lenox Hill Hospital, January 10, 1933, with the following history. Ten days before he was suddenly seized with very severe general abdominal cramps followed by stabbing pain in the epigastrium. Since that time he has had persistent intense soreness in that region. Pain has radiated to both shoulders, and at times through to the back. There has been some nausea but no vomiting and the appetite has been poor. He has not been jaundiced. There have been no respiratory or cardiac symptoms.

At onset of attack he was unable to void and had to be catheterized, but there has been no difficulty since. He has had fever and has lost considerable weight. Hiccough developed on the day of admission and has been very annoying.

In the past history the only item of interest was belching of gas for several months, most marked about two hours after his midday meal, and relieved by sodium bicarbonate.

He had a temperature of 103.2°, pulse 112, respiration 28. There were signs in the chest suspicious of a pneumonic infiltration about the angle of the scapula on the left side. The other definite findings were tenderness in the epigastrium and an apparently enlarged liver, the margin of which could be felt three fingers below the costal arch. Blood examination showed the following: Red blood cells, 4,950,000, hæmoglobin, 90 per cent, white blood cells, 20,900, polymorphonuclears, 77 per cent, leucocytes, 23 per cent. The urine showed 2+ albumen, and an occasional granular cast. There was no sugar or other abnormal ingredients. A blood chemistry examination done the following day was within normal limits.

Bedside rontgen films were made with the patient sitting up. The chest was negative. A fluid level was visible in the upper abdomen, about two inches below the dome of the diaphragm and extending almost from one side of the abdomen to the other. Above this fluid level a small collection of air was visible. The lower border of the right lobe of the liver was seen on a level with the crest of the ilium (Figs 1 and 2).

At the time of the surgical consultation January 11, 1933, the patient looked very sick. His eyes were sunken, and the tongue heavily coated. There was a temperature of 103.8° , with a pulse rate of 108. The lungs were clear. The abdomen was flat and nothing abnormal could be made out over the lower portions. In the epigastrium, extending about halfway down from the ensiform to the umbilicus and equally to both sides, there was marked fullness with tenderness and rigidity. A diagnosis of subphrenic abscess was made, most likely due to a perforated gastric ulcer.

Immediate operation was performed under general anaesthesia. A median



FIG 1—Bilateral subphrenic abscess eleven days after perforation of a gastric ulcer



FIG 2—Collection of air under both diaphragms eighteen hours after perforation of a pyloric ulcer

epigastric incision was made and a large abscess cavity entered. After evacuating about 1,000 cubic centimetres of creamy yellow pus by suction the cavity could be inspected. It was situated just beneath the diaphragm, the floor was formed by the liver which had become adherent to the anterior abdominal wall. Toward the right the cavity was walled off, apparently by the falciform ligament, while toward the left a finger could be passed around the edge of the liver into a deep-seated cavity toward the stomach. The origin of the pus could not be definitely determined but was assumed to be secondary to a perforated ulcer.

Culture of the pus showed pneumococcus type III, while the smear showed Gram-negative bacilli, Gram-positive bacilli, and Gram-positive diplococci. The patient ran a rather stormy course for about two weeks, with temperature ranging from 100° to 103.8° . During this period he had a bilateral bronchopneumonia, verified by rontgen examination. On typing his sputum there was no agglutination with types I, II, or III.

As soon as he had recovered sufficiently a study was made of his gastro-

intestinal tract. The test meal showed free acid to be normal, while the total acid was rather high. There was no blood present. Röntgen examination showed constant deformity of the prepyloric region with an ulcer niche on the lesser curvature. There was no six-hour retention. The patient was transferred to the medical service for prolonged ulcer treatment and was discharged from the hospital two months after admission. He has been kept under observation but he has no abnormal symptoms at present.

He was presented because of the long time which elapsed between the perforation and admission to the hospital, and because of the aid in diagnosis furnished by the flat X-ray examination of the upper abdomen. The presence of air under the diaphragm is taken as an indication of the perforation of a hollow viscus. Owing to the long time which elapsed in this case an inflammatory exudate developed secondarily to the accumulated fluid resulting from the perforation. The presence of pneumococci is probably due to secondary invasion. He apparently had pneumococci in his system because he had signs suggestive of pneumonia at the time of admission and he developed bilateral bronchopneumonia due to pneumococci after operation.

Soon after admission of this case another patient came to the service of the reporter with the diagnosis of perforated ulcer. In him also the X-ray was of considerable help in substantiating the diagnosis. Air was shown under both diaphragms, but, owing to the recent perforation, no fluid had formed. It is not common to see such a large collection, usually there is but a small amount which becomes visible just beneath the diaphragm. It is important to select the proper position for X-ray, for when lying flat the air may not show, while in the sitting position the liver drops down slightly and allows air to become visible between it and the diaphragm.

DILATATION OF COMMON DUCT WITH PAIN AND JAUNDICE THREE AND ONE-HALF YEARS AFTER CHOLECYSTECTOMY

DOCTOR EGGERS presented a man, forty-seven years of age, who was admitted to the Lenox Hill Hospital, May 30, 1928, on account of attacks of pain in the right upper abdomen, which had occurred over a period of three months. He had signs of acute cholecystitis with a temperature of 102.2° , and a pulse of 102. The white blood cells were 9,800, with 82 per cent polymorphonuclears. There was no jaundice and the icteric index was 10. The Wassermann test was negative. There was no contraindication to operation, and a few days after the temperature reached normal a cholecystectomy was done under general anaesthesia. Palpation of the common duct did not reveal any stones or other abnormality. The abdomen was drained with a cigarette drain and there was some bile drainage for a while. The pathological examination showed acute hæmorrhagic and chronic cholecystitis and cholelithiasis. Culture of the bile was negative. The convalescence was uneventful and the patient was discharged, cured, four weeks after operation.

He was re-admitted nine months later, March 15, 1929, complaining of burning pain in the stomach, which had suddenly started two weeks before. It had gradually become more intense, had remained localized in the mid-epigastrium and was associated with occasional vomiting, loss of appetite, and marked constipation. He had severe pain when first examined and he was quite jaundiced. The abdomen was soft and the liver not enlarged. There was tenderness in the epigastrium and along the right costal arch without rigidity. A diagnosis of probable calculus in the common duct was made.

During a period of observation, lasting three weeks, he had several attacks of pain and vomiting and the temperature varied from normal to 101° . Blood chemistry was within normal limits, and a blood count showed 12,400

white blood cells with 84 per cent polymorphonuclears. The coagulation time of the blood was considerably increased and the Van den Bergh test was reported direct, positive, immediate. On admission the icterus index was 55, it then came down for a while but went up to 71 later, and from that time on gradually fell to normal. Coincident with this there was symptomatic relief and the patient was discharged with the most likely diagnosis of common duct calculus, which had passed.

December 3, 1931, almost three years later, he was admitted for the third time, on account of acute epigastric pain which had begun suddenly a few hours before. He stated that since his last previous discharge he had had a number of comparatively mild attacks of pain, seldom lasting over an hour. Except for these attacks he had considered himself in good health. He was quite jaundiced, his icterus index was reported to be 27. The abdomen was soft, there was separation of the fascia in the old scar, but without any hernial protrusion. The liver edge could not be felt, and no abnormal mass could be made out.

Laboratory examinations did not help in establishing a definite diagnosis. Wassermann was again negative. Röntgen-ray examination did not show any stone nor a dilated common duct. There was a slight fever, the highest point being 101.4°. A diagnosis of obstructive jaundice was made, probably due to pressure on the duct from without, by means of old adhesions producing angulation, or due to a stone within the duct. With recurrent attacks an operation seemed indicated.

The old scar was excised. It was found that the fascia had completely separated and that the omentum was adherent to the scar as well as to the margins of the fascia defect and internal organs. There were also additional extensive intra-abdominal adhesions involving two loops of small intestines and the liver. After much difficulty the bile-duct system was exposed. The common duct was enormously dilated to the size of the duodenum, but its wall was not particularly thickened. After mobilizing the duodenum palpation of the common duct and pancreas was possible. There was no stone within the duct, but the pancreas was hard and nodular for its entire length. The nodules were visible through the peritoneum, and in parts the latter was adherent to them. Several small areas of fat necrosis were seen, but there were none at a distance from the pancreas.

No cause for the dilatation of the common duct could be found except the extensive adhesions, or the pancreatitis. In order to determine the patency of the duct a choledochotomy was done. A considerable quantity of thin, fairly clear bile was aspirated. (It was later reported sterile.) The duct was so large it could easily be explored with the index finger, there was no stone present and no tumor could be felt. Downward the finger apparently passed through a dilated papilla into the duodenum. Subsequently a bougie was passed down through the duct into the duodenum. With an open papilla there seemed to be no reason for drainage of the duct. The opening was therefore closed with interrupted chromic catgut sutures. Two cigarette drains were inserted and the abdominal wall was then repaired.

The explanation of the symptoms and findings in the patient were difficult. The three definite findings were extensive adhesions, a dilated common duct and papilla, and chronic pancreatitis which had apparently been acute at some time. The dilated duct was apparently not due to mechanical obstruction, at least none was found at operation. It may be explained on the theory of spontaneous dilatation, having assumed the function of the gall-bladder, but the dilated papilla could hardly be explained on this theory. There may be disturbance of the nerve control of the duct secondary to acute pancreatitis.

with possible involvement of sympathetic ganglia. The patient probably never had a common duct stone although there is a possibility that the dilated papilla was due to the passage of a large stone into the duodenum. The two attacks of severe abdominal pain may have been due to acute pancreatitis and the associated jaundice due to temporary obstruction or to regurgitation of bile or duodenal contents through the dilated papilla into the common duct.

The prognosis seemed doubtful. If the papilla remains dilated one may reasonably expect repeated regurgitation into the common duct with possible ascending infection and secondary damage to the liver and pancreas. To test out this possibility a duodenal tube was passed about three weeks after operation. When the end of the tube was in the region of the ampulla, lipiodol, and later a thin bismuth emulsion, were forcibly injected and observed under the fluoroscope. It was impossible to outline the biliary ducts, the opaque mixture passed rapidly downward into the small intestines. It appeared from this observation that rather high pressure is required before duodenal contents can enter the common duct. In order to create such high pressure it seemed necessary to temporarily obstruct the duodenum at a place somewhat below the papilla and thereby simulate conditions such as may be brought about by spastic contracture of the duodenum.

A special duodenal tube was therefore constructed by Dr. Alvin G. Dujat for this purpose. It consists of two pieces of 0.4-centimetre duodenal tubing of conventional length joined together at four-inch intervals with silk ligature material. Both tubes are fitted with a closing valve at the oral end, and one, which is four inches longer than the other, is equipped at its duodenal end with a small inflatable rubber balloon arrangement which is, of course, inflated from its oral end with air after it has passed through the pylorus into the duodenum. Inside the rubber balloon is a metal "duodenal bucket" which aids in visualizing progress of the end of the tube through the stomach and duodenum. When pumped up with forty to sixty cubic centimetres of air, the balloon occludes the lumen of the duodenum and allows an opaque solution to be injected into that portion of the gut just proximal to it through the other tube which runs parallel to the first tube (in a double-barreled fashion) and empties a few inches proximal to the occluding balloon (Fig. 1).

At the conclusion of the procedure the balloon is simply deflated and the whole apparatus withdrawn.

This tube was successfully passed on the patient, it entered the duodenum without difficulty and its tip was observed in the proximal portion of the jejunum about twelve hours later. The following observations are recorded by Doctors Dujat and H. E. Illick.

The tube is pulled back so that the occluding bulb can be inflated at the lower end of the descending duodenum. The inflation was done and easily visualized under direct fluoroscopy and forty-five cubic centimetres of air were injected before the patient complained of a slight pain in the epigastrium. An aqueous suspension of barium sulphate is then slowly injected just proximal to the occluding bulb. About 100 cubic centimetres is seen under the fluoroscope to fill out the first and second portions of the duodenum but none appears to enter the common bile-duct. As soon as an attempt is made to inject a little more barium sulphate solution, the irritable duodenum suddenly expels the whole mass of barium and occluding bulb into the jejunum about eight inches distal to the duodenojejunal junction. The process is repeated, using about fifty-five cubic centimetres of air, and now the irritable duodenum cannot eject the occluding bulb. Injection of 100 cubic centimetres of barium sulphate is seen to start to fill the descending duodenum and then with remarkable suddenness it is shot back into the stomach and is seen at the lower part of the greater curvature and some is seen even up as high as the cardiac end. The duodenal cap alone is seen to retain a fairly well filled-out appearance. None is seen to enter the common duct which was found so dilated at operation about a month

ago It is deemed inadvisable to attempt any more forceful measures to fill the dilated bile-duct and the tube is withdrawn, tested, and found to be functioning as well as when passed

From these observations it did not seem likely that the patient would have any trouble in the future due to regurgitation His convalescence was entirely uneventful and he was discharged, cured, five weeks after operation There have been no symptoms suggestive of gall-bladder or pancreatic disease since then

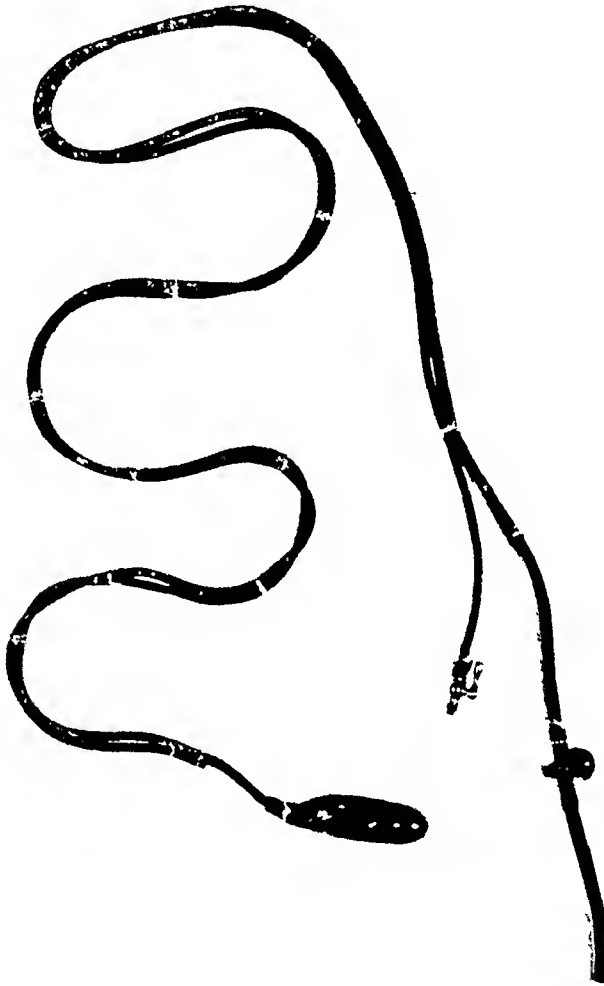


FIG 1.—Double duodenal tube used for obstructing duodenum and attempting regurgitation into the common duct

Final diagnosis—Dilated common duct with obstructive symptoms probably due to chronic pancreatitis

DR ALLEN O WHIPPLE stated that there was a definite group of cases developing jaundice a considerable period after a cholecystectomy in which chronic pancreatitis as an obstructive agent was a definite finding This group of cases has to be differentiated from those caused by trauma to the duct, or by failure to remove a common duct stone or a recurrent stone At the Presbyterian Hospital there have been some five cases in which the jaundice, appearing two or more years after a cholecystectomy, was found to

be due to a chronic pancreatitis. In two of these an anastomosis of the common duct and stomach was done, with relief of jaundice. In the other cases the common duct was drained over a long period of time.

The duodenal intubation for the study of pancreatic ferments and of bile and crystals in the duodenal contents may prove of definite help in differentiating the cases of common duct stone and pancreatic disease. In Doctor Whipple's opinion Doctor Eggers' patient gave a history of previous attacks of subacute pancreatitis resulting in a thickening of the pancreas as found at operation.

DOCTOR EGGERS rejoined that he was not convinced what the actual mechanics underlying the symptoms are. In the case presented there were extensive adhesions, a very much dilated common duct, and a chronic pancreatitis. In spite of these findings, however, no mechanical obstruction could be demonstrated. At the time of operation the common duct was patent. The adhesions apparently played no rôle in the symptoms, a stone or a tumor was not found, and the conclusion is forced on one that the pancreatitis in some way was responsible for the symptoms. It is possible that the degree of obstruction of the common duct varies with the degree of swelling and œdema of the pancreatic tissue. It is also possible that no complete obstruction of the duct is necessary to produce dilatation and sufficient backing-up of bile into the liver to produce jaundice. When one considers that the wall of the common duct is thin and contains only a few muscle fibres, it is conceivable that it may dilate easily and by this very dilatation favor a certain degree of stagnation within it, and that this stagnation in turn, aggravated by a moderate degree of pancreatitis, produces backing-up of bile into the liver. In cases with infected bile the production of jaundice may be explained on the theory of the infection spreading up into the liver and producing a certain amount of hepatitis. In the case presented, however, the bile was sterile both at the time of the first and second operations. Here, no doubt, the mechanical factors were the more important.

Doctor Eggers reported another similar case which is at present under his care. A woman of seventy-one years of age was first seen by him in March, 1932, when he operated on her for acute perforated cholecystitis. Several hundred small gall-stones were removed and a subphrenic abscess, the culture of which showed *Bacillus coli communis*, was drained. On account of the extensive infection the gall-bladder was not removed, but drained. The patient recovered and remained well for about a year. Recently she again had several attacks of severe right upper abdominal pain with vomiting, fever, and jaundice. Röntgen-ray examination was negative. A diagnosis of obstructive jaundice was made, probably due to a common duct stone. On account of the former perforation many adhesions and great technical difficulty had been anticipated, but only light adhesions were found. All organs of the region were easily exposed. The gall-bladder was small, thick-walled, and did not contain stones. It was aspirated and clear bile

obtained, indicating normal function. The common duct was enormously distended to about the size of the duodenum. No stones were felt within it, even after aspirating its contents of thin, clear bile, but a hard, nodular tumor could be felt which at first impressed as a tumor of the papilla, but was later identified as pancreas. A diagnosis of probable carcinoma was made. A cholecystgastrostomy or choledochogastrostomy was technically feasible but under existing conditions threatened to produce too much tension with subsequent leakage and was therefore not done. On account of slight leakage from the puncture holes in the gall-bladder and common duct a cigarette drain was inserted and the abdomen then closed. The culture of both specimens of bile showed colon bacilli. In spite of that the convalescence was uneventful, the jaundice cleared up completely, and the patient has been discharged cured. The clinical diagnosis had to be changed from carcinoma of the pancreas to chronic pancreatitis.

CHRONIC EMPYEMA WITH COMPLETE COLLAPSE OF THE LUNG

DOCTOR EGGERS presented a boy, sixteen years of age, who was first seen by him October 15, 1931, in consultation with the attending surgeon. The boy had contracted influenza the last week of January, 1931, complicated by pneumonia on the right side. After a very severe illness of two weeks, with high fever and delirium, the temperature had come down slowly but never quite reached normal and then began to rise again. Empyema was diagnosed and a rib resection done twenty-six days after the onset of pneumonia. An enormous quantity of pus is said to have been evacuated. The first X-ray examination after operation showed complete collapse of the lung (Fig 2). Drainage from the chest continued profuse, but the general condition improved slowly. He gained weight and was discharged from the hospital about two months after operation with a draining sinus. His surgeon had tried everything within his means to bring about reexpansion of the lung and obliteration of the cavity, and when nothing succeeded he had allowed the wound to close in the hope that reexpansion would be favored by a closed rather than an open empyema cavity. The accumulating pus he had removed by frequently repeated aspirations. Under this treatment the patient had gained weight, from a low 90 pounds, to 142 pounds, and a certain amount of reexpansion of the lung had taken place. When seen by Doctor Eggers about eight months after operation the chest condition was stationary. His general condition was quite good. The right chest showed the following changes. Anteriorly there was flatness with very limited respiratory excursions. Posteriorly there was a healed scar over the ninth rib in the posterior axillary line from the empyema operation and numerous scars from subsequent punctures. There was flatness below with absent fremitus and diminished breath sounds. Above breath sounds were heard anteriorly and posteriorly especially toward the mid-line. No splashing sound was heard. The right shoulder drooped slightly and there was a tendency to deviation of the spine. There was no clubbing of the fingers. The abdomen was negative except for a liver palpable one finger below the costal margin. X-ray examination showed a pyopneumothorax with the lung expanded about 50 per cent. The problem was presented of dealing with the constantly accumulating pus and of bringing about reexpansion of the lung. Establishment of open drainage was advised to prevent absorption of pus and the formation of a thick disabling pleura over a partially collapsed lung. It was felt that con-

tinuation of the treatment then in use would surely lead to chronicity and require a radical operation later

This opinion was not looked upon favorably. The family was very reluctant to have any operation performed. It was therefore decided to continue more conservative measures for a while. In turn his attending surgeon used frequently repeated aspiration, closed catheter drainage with suction, and the use of James bottles and exercises. When everything failed he resected a portion of the eighth and ninth ribs together with the underlying thickened parietal pleura and established open drainage. There was improvement in the general condition, but the chronic empyema remained stationary. The right chest was flat and did not expand at all. There had never been evidence of a bronchial fistula. The heart was not displaced.

A radical operation was finally decided on. The cavity was quite clean, as the drainage opening was at its dependent part, just above the diaphragm. There was no fever. The blood count showed 5,370,000 red blood cells, 90



FIG 2—Complete collapse of lung after operation for acute empyema

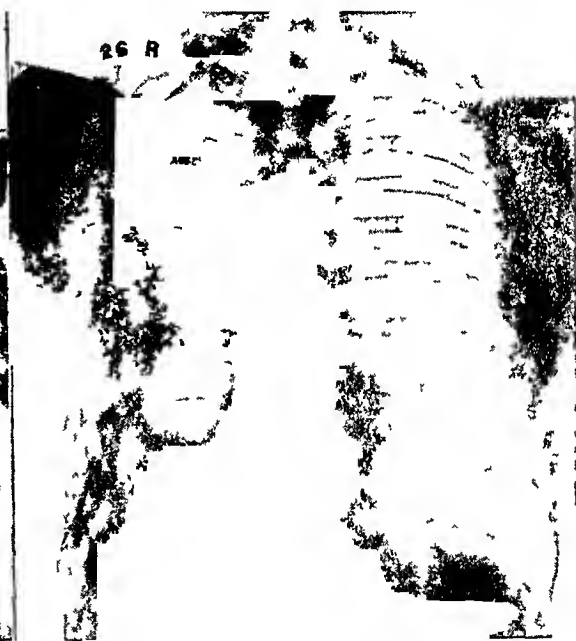


FIG 3—Final result after partial reexpansion and radical operation

per cent hæmoglobin, 11,950 white blood cells, 71 per cent polymorphonuclears, 28 per cent leucocytes, 1 per cent eosinophiles. Culture of the secretion from the wound showed *Bacillus alkaligenes*, while the smear showed Gram-negative bacilli, staphylococci, and short chain streptococci. The urine showed a trace of albumen.

The operation was performed twenty months after his original rib resection. It was done in two stages with an interval of four weeks. At the first operation a portion of the eighth, seventh, sixth, fifth, fourth and third ribs were resected together with the thickened parietal pleura. This completely exposed the cavity. A narrow sinus was found to extend upward from the apex of the cavity for a distance of an inch. There was another narrow recess extending along the costophrenic sinus both anteriorly and posteriorly. The granulations lining these recesses were removed with a spoon. An attempt was then made to decorticate completely the exposed lung but this was not possible. The visceral pleura was very closely adherent to it and apparently there were fibrous tissue bands extending down into the lung substance. Criss-cross incisions were therefore made over the visceral pleura

but no expansion resulted, even on straining. The lung tissue had apparently been damaged by the long collapse and fibrous tissue changes had taken place within it. One more attempt was made to favor reexpansion by completely mobilizing the lung, but that also failed. To avoid shock the operation was terminated at this point. Drainage tubes and tampons were inserted and the muscles and skin closed around them. The tampons were removed a few days later and the patient was encouraged to practice respiratory and arm exercises and to use James bottles. No improvement resulted and it became evident that a complete thoracoplasty would have to be done in order to bring the chest wall down to the partially expanded lung.

The second stage consisted of the removal of a portion of the first and second ribs, as well as additional pieces of the formerly resected third, fourth and fifth ribs. In the lower chest a portion of the tenth rib was removed as well as the re-formed ninth rib. There was considerable shock following this procedure, but after that had been overcome the convalescence was quite smooth and the patient was discharged with a narrow sinus, December 24, 1932.

His condition has been very good since then. The sinus has healed, he has no abnormal symptoms and is able to carry on satisfactorily. To prevent increase in the deformity which was beginning to manifest itself when first seen by Doctor Eggers, he has been encouraged to breathe deeply and to practice setting-up exercises. He wears a brace, the use of which is to be continued during his adolescent years. (Fig 3)

This case is presented to call attention to the difficulties which are encountered in these patients with a completely collapsed lung. Fortunately these cases are rarely seen. A complete collapse, as shown in this case, must be due to positive pressure on the outside of a lung without the presence of any intrapleural adhesions. Clinically there seem to be but two causes for this, either an open pneumothorax, or perforation of a suppurative intrapulmonary focus into the pleura, with an associated bronchial fistula. The result is complete collapse of the lung, which is quite different from the condition found in the usual empyema. During the development of an ordinary empyema the lung does not collapse, it is compressed to the degree necessitated by the amount of fluid present. Usually adhesions form to surround the fluid and attach the lung to the chest wall. As soon as pus is evacuated there is a tendency for the lung to reexpand and assume its normal position in the thorax. This is the process observed during the healing of the great majority of empyema cases.

It is only when the fluid forms so rapidly and in such great quantity that no adhesions have a chance to form, that there is danger of a lung collapse on opening the chest. It is for this reason that delay in operating acute cases, and aspiration and closed methods of drainage are advocated.

If an acute collapse in the presence of an open chest has occurred, it is very difficult to bring about reexpansion, unless one establishes very early negative pressure within the chest by means of a system of drainage bottles. Later on the pleura becomes thickened, changes take place within the lung and the most one can hope for is partial reexpansion. Nature will do a great deal to obliterate the large cavity by drawing the mediastinum over into the

affected side, by collapsing the chest wall and by drawing up the diaphragm. Unfortunately, however, this is usually not enough and it becomes necessary to collapse the chest wall sufficiently to meet the partially expanded lung, as was done in this case.

DR JOHN F. CONNORS referred to two cases of chronic empyema with complete collapse of the lung which he illustrated with lantern slides. The first case was a young woman, twenty-four years of age, who was admitted to the hospital with an *empyema necessitatis*. This was in 1929 and at that time treatment consisted in freeing all adhesions found in the pleural cavity. This case was treated by the packing method. Ultimate cure was obtained in four months. The X-ray showed the collapse of the lung which was almost complete. A second X-ray showed the lung expanded to the chest wall, and there was plain evidence of a collapse of the chest wall—a thoracoplasty done by nature. The second case, a stab wound of the chest, developed pyopneumothorax which was drained by a tube. The X-ray, taken one month later, showed complete collapse of the lung which was plastered to the spine. The patient was readmitted to the hospital for a decortication and with the belief that packing would help to clean the surface of the lung this was done. It was allowed to remain for five days. Astonishing as it may seem, when the packing was removed the lung surface was clean and the lung began to move. There were no further packings and the last X-ray taken showed a complete cure at the end of three months.

SOLITARY BONE CYST—THE LOCALIZED FORM OF OSTEITIS FIBROSA CYSTICA

DR BRADLEY L. COLEY read a paper with the above title for which see page 432.

DR NORMAN L. HIGINBOTHAM (by invitation) said there were one or two points in this study which should be emphasized. One, that osteitis fibrosa cystica is a multiple lesion, but the paper deals with a single lesion. In all the cases in this series of twenty-six the blood calcium determination was normal. When a lesion such as was shown in the slides is present they believed it worth while to take skeletal X-rays to determine the presence of bone lesions in other parts of the body. In the twenty-six cases treated by different surgeons it is obvious that they had different methods of treatment. The choice, however, is the surgical treatment Doctor Coley mentioned, that is, thorough curettage of the bone cavity and primary wound closure. Most of these cases occur before the age of twenty. Therefore irradiation is contraindicated because it inhibits epiphyseal growth and union.

DR FREDERIC W. BANCROFT called attention to the point that Doctor Coley had brought out relative to the definite anatomical distribution of the lesion. A study of the distribution of the nutrient artery in children showed that the terminal branches of the nutrient artery supplied the metaphysis and that there is a very poor anastomosis with the epiphyseal vessels. One might assume, therefore, that this is some type of vascular occlusion of the terminal branches of the nutrient artery, associated with decalcification. While it is true these lesions heal after fracture, recurring fractures are far

too common. The treatment, therefore, should be aimed toward preventing fracture and to create some means of increased calcification within the cyst.

Doctor Bancroft took issue with Doctor Coley on the question of straight curettage, because he believes that something should be added that would stimulate osteogenesis. He showed slides of two cases, one in which a bone transplant from the fibula had been introduced and another one where small bone chips had been introduced. Late follow-up pictures showed osteogenic repair.

It had seemed to Doctor Bancroft that frequently a Brodie's abscess and osteitis cystica fibrosa were wrongly diagnosed on radiological evidence.

Doctor Coley emphasized his belief that conservative surgery is the best form of treatment and, as experience with this work has grown, he feels less content with the permanence of the repair which takes place spontaneously following a pathological fracture. Curettage, with or without the use of bone chips, seems to give the most satisfactory and lasting results.

BRIEF COMMUNICATIONS

FRACTURE OF THE HYOID BONE

THE following case of fracture of the hyoid bone is reported because this lesion is comparatively rare. It occurred several hours after an operation on a distant part of the body without any definitely known cause. Apparently this is the only recorded case complicated by a subcutaneous emphysema.

CASE I—A muscular and very powerfully built man, twenty-one years old, sustained an injury to the external semilunar cartilage of his left knee while in a football scrimmage. This joint was subjected to operation for removal of the damaged meniscus December 23, 1932. The operation and the anæsthesia were uneventful. At no time during the induction of the narcosis or the operation was there any struggling or unusual muscular activity. After the operation nothing unusual was observed.

In the afternoon of the day of operation, which was performed at eight in the morning, the patient complained of a sore throat and pain in the chest. An examination of the chest was negative, the discomfort in the throat was assumed to be an irritation from the anæsthetic, which was gas-oxygen-ether. On the following morning the patient, who was a quiet, stolid individual, complained of a severe sore throat. He had difficulty in opening his mouth. Articulation was painful and he spoke in a whisper. He had spat up some blood. His neck and chest were swollen from a subcutaneous emphysema, extending down to the nipple line and up on both sides of the neck to the angles of the lower jaw. A more careful investigation revealed a congested, swollen, beefy pharynx, with marked redness and œdema of the uvula and soft palate. There were several ulcerations on the uvula. There was marked tenderness in the upper part of the neck. Laryngoscopic examination was difficult but showed no gross lesion of the cords or surrounding structures. The patient spoke only in a loud whisper, stating that he thought he could speak louder but for the pain. Swallowing was painful.

It was assumed that the metal tongue depressor used during the anæsthetic had damaged in some way the mucous membrane of the mouth, although the anæsthetist insisted that at no time was there any occasion for rapid or violent insertion of this instrument. On the following day all the symptoms persisted. An X-ray picture was made of the neck which revealed a fracture of the hyoid bone at the junction of the body with the greater cornua (Fig 1). The discovery of this lesion explained all the symptoms. The fragments of the hyoid bone had evidently perforated the mucous membrane of the floor of the mouth, with resultant entry of air into the subcutaneous and fascial planes, causing the emphysema, and the extreme congestion of the soft palate, pharynx and larynx. More careful palpation of the neck revealed tenderness to pressure limited to the body of the hyoid bone. There was no crepitus.

The symptoms continued for about a week and then rapidly subsided. When discharged from the hospital a little over two weeks after the operation the patient was comfortable. The swelling of the neck and chest had disappeared. There was no dysphagia or soreness of the throat, and speech was normal.

An X-ray of the hyoid bone made at that time showed the body and cornua to be in practically normal relation. The wide gap seen in the original film has been greatly reduced, although no manipulative reduction had been attempted.

A review of the literature on this subject reveals the fact that in every case there was a known injury, leaving no doubt about the mechanism of production of the fracture. There are three well-established causes for fracture of the hyoid bone. (1) Direct injury as in strangulation, run-over

accidents, or a direct blow on the side of the neck (2) Indirect violence as a sudden hyperextension or flexion of the neck in a fall (3) Muscular violence as in forcible swallowing In my case it must be assumed that the cause was an abnormally severe contraction of the neck and throat muscles Direct violence is out of the question, and even indirect violence through post-operative restlessness may be ruled out, as this patient was under continuous observation and had been unusually quiet Additional confidence



FIG. 1—Lateral roentgenogram of neck showing bilateral fracture of the body of the hyoid bone with separation of the body from the greater cornua

may be placed in the muscular theory as this patient is of a very powerful build with very strongly developed muscles all over his body, and also in the neck

SAMUEL KLEINBERG, M D
New York, N Y

PATELLA BIPARTA

THIS X-ray picture (Fig 1) illustrates a rather unusual type of what is called *patella biparta*, indicating two centres of ossification The chief interest in the anomaly is that if discovered after an injury to the knee in an adolescent, it may be mistaken for a fracture From this it may be distin-

PATELLA BIPARTA

guished by the smooth outlines and symmetrical relation of the two segments as in this instance

A more common and more important form is what is sometimes called fragmentation, when there are several small ossifying centres, usually near the outer and upper border of the patella. This condition is usually discovered in investigating the causes of discomfort or disability at the knee, and it may be mistaken for a new growth. In rare instances it may be the cause of symptoms, either by actual irritation—"osteochondritis"—or irregularity in development that may induce friction. Occasionally the fragmentation may be at the lower border of the patella and may be mistaken for a floating body, or the patella may be divided into two fairly equal parts, lying side by side or one superimposed on the other.

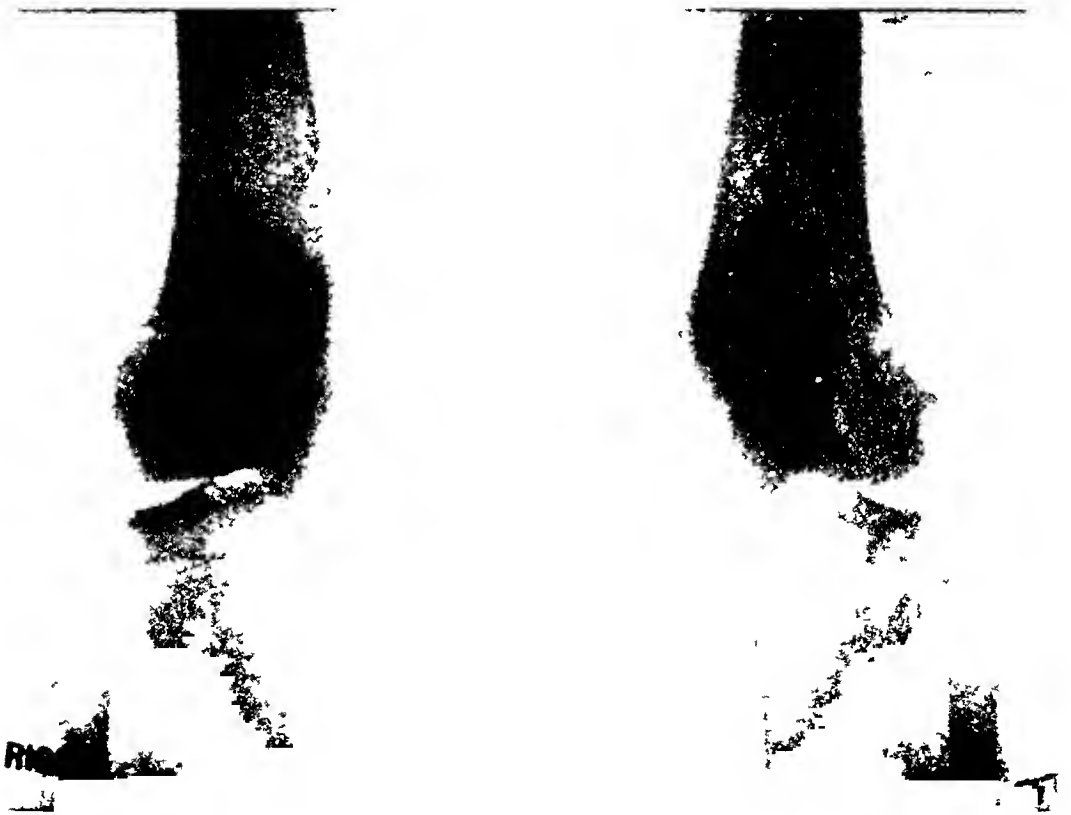


FIG. 1.—The anomaly described is on the right side and on the internal border of the patella. A similar condition is to be seen on the left side, an important point in diagnosis.

In the second class of cases operative removal may be indicated, but in most instances it is an accompaniment rather than a cause of the symptoms. A very important point in the diagnosis is that the anomaly is usually bilateral as in this instance. Thus in doubtful cases an X-ray picture of the sound knee should always be made.

According to Dueño, the most recent writer on the subject, who has investigated eighty cases recorded in literature 75 per cent were fragmentation in the situation described, 20 per cent below the patella, and but 5 per cent of the lateral type were presented (Rev. de Cirug. de Barcelona vol. 2, p. 137, 1932).

ROYAL WHITMAN, M.D.

New York, N. Y.

AVERTIN IN THE PAIN CRISES OF BLOOD-VESSEL SPASM

PERHAPS the most difficult and trying feature connected with blood-vessel disorders of the extremities is the break in morale that frequently comes as a result of the prolonged suffering most patients are compelled to endure. Operative attack on the sympathetic nervous system and nerve injection or nerve section are of certain usefulness in providing relief, but only too often the battle is lost before ever the patient comes in and prompt amputation offers the only hope of salvation. Occasionally, too, more especially in instances of multiple extremity involvement, the situation is so serious and so tragic that one is at his wits' end to know just where to begin or what to do. Such a case presented itself to us recently and after much trial and tribulation we solved it in such an unusual manner—by the continued use of avertin—that we felt an early report would be in order that others might have the advantage of what would seem to be a comparatively harmless but very effective method of procedure. We know avertin has been used similarly in other maladies,¹ but so far as it has been possible for us to determine it has not been employed in blood-vessel conditions.

The case is as follows. L. S., male, aged thirty-two, was operated on by Dr. Harvey B. Stone, of Baltimore, April 1, 1930, for pain and threatened gangrene of the right foot. Doctor Stone did a peri-arterial sympathectomy on the right femoral artery, following which, with the exception of losing the distal half of one toe, the patient made a complete recovery. Thus far he has had no further pain or discomfort in that leg and has been able to walk on it without difficulty.

In the early spring of 1933 he began to have pain in the first and second fingers of his right hand and later on, some one having accidentally stepped on his left foot, an ulcer developed under the big toe at its base. In spite of the warning he had had in 1930, at which time a diagnosis of Raynaud's disease was made, patient did not seek medical advice until early in August (1933). We did not see him until a month later, at which time his condition was so serious that he was sent at once into the Union Memorial Hospital. At that time there was a rather deep excavated ulcer just under the proximal joint of the left big toe, which looked ominously blue. He was not, however, having any pain in this toe or foot. He was having most of his pain in the first and second fingers of the right hand. The distal end of the first finger was already gangrenous, while the tip of the second finger was threatened with gangrene. The patient's right foot and his left hand were quite all right as regards pain, although the left hand was at times rather uncomfortable. By the time we saw him the patient had been having so much pain and so much suffering that his physician had been compelled to give him all kinds of sedatives, other than morphine, but they had given little or no relief and his nerves were obviously badly shattered. He had lost much sleep, he was thin, very pale, perspired very freely, and was much concerned about his condition. Like most other patients of this character he was a great cigarette smoker.²

On examination at the Union Memorial Hospital we found that his general condition was fair but that the blood-vessels of his extremities were sadly blocked. No pulse in either leg could be felt below the femoral at the groin, and neither radial pulse could be obtained. The ulnar artery could be felt pulsating at the left wrist and both brachials could be felt at the elbow but there was a very definite diminution of the blood supply to both hands. We rather felt that a peri-arterial sympathectomy on the right brachial artery was indicated and the patient was quite willing to have it done, but he was so nervous and upset that it was thought best to try to carry him along for a few days to see what could be accomplished conservatively.

It was impossible, though, to give him any rest. We used repeated doses of codeine, luminal, sodium amytal, together with other similar sedatives, but he just could not sleep or even rest. He had a peculiar twitching even when he was drowsy and at the slightest provocation would break out into a profuse sweat. A few days (by B M B) on September 6, 1933—at his own insistence, a peri-arterial sympathectomy was done on his right brachial artery, local anæsthetic, novocaine, being used. On the very next day patient developed a violent generalized urticaria, but small doses of adrenalin cleared it up in twenty-four hours.

Following this, the patient had definitely less pain in the affected hand and arm, but he still was absolutely unable to rest. He twitched and he tossed and complained constantly. His left foot began to pain him and then his left hand (the unoperated one) became more uncomfortable. The pain was not so terribly acute anywhere but little things annoyed him enormously. We tried giving him large doses of sodium amytal and then larger doses of codeine, together with the various sleep-producing drugs, but nothing helped. It was only when we gave him morphia that he got any rest at all, and this was fleeting. It seemed as if the man would go insane or pass out from sheer exhaustion unless something could be done, so in the emergency we decided to put him to sleep with avertin and keep him there for a period of days, if necessary.

The first dose was given to him September 9 at 9 P M, the dosage being seventy milligrams per kilo. This was rather small and we rather felt that it would take much larger doses to achieve profound narcosis, but the man's physical and mental condition left so much to be desired that we decided to proceed slowly and cautiously—even though permission had been granted us by the family to use any and all means to give rest. The blood-pressure, which had been 125/90 on admission, but was only 108/70 at the moment, dropped to 106/66 and patient became very restless and pretty much unmanageable in spite of the fact that he was not conscious. This lasted three hours, at the end of which time it was thought best to give Schlessinger's solution, minims 10, by hypodermic, which supplemented the waning action of the avertin. At 5 A M he waked up but remembered nothing after the instillation of avertin. Unsatisfactory though this first trial was, it was the best night since he had entered the hospital.

Averse to giving him more avertin at the moment because he seemed so weak, we carried him through the day on the usual sedatives as best we could. At 9 P M the following night (September 10), he was given eighty-five milligrams per kilo of avertin. His blood-pressure, which had in the meantime resumed its normal level, remained steady at 124/68. He rested quietly until 11 30 P M, that is, two and a half hours. When he waked up he was given thirty milligrams per kilo more of avertin. His blood-pressure remained the same and this produced rest until 3 A M, at which time he was given morphine sulphate, grains $\frac{1}{4}$, by mouth. He then went through the rest of the night satisfactorily and during the next day seemed somewhat quieter.

On September 11, at 10 15 P M, he was again given eighty-five milligrams per kilo of avertin, but this carried him for only one and a half hours. So at 1 20 A M he was given forty milligrams more, following which he became restless and unmanageable. His blood-pressure remained at 127/80. At 3 A M he was given $\frac{1}{4}$ grain morphine orally and rested fairly well. The following morning he stated that he slept well during the night but he did not feel that it was a natural sleep. *Patient had a fairly comfortable day following this and did not need any sedatives to speak of.* On the night of September 12 he was given ninety milligrams per kilo of avertin at 10 30 P M. At 11 P M his respirations were somewhat shallow but became normal within thirty minutes. His blood-pressure was 120/78. He slept then for three hours, after which he was given $\frac{1}{6}$ grain of morphine sulphate, followed forty-five minutes later by $\frac{1}{4}$ grain, both by mouth. We hated to give him this morphia, but each time he came out of the avertin he fussed about so much that it had to be given in order to keep him quiet.

The next day—September 13—patient seemed somewhat drowsy but he was awake most of the time and was able to take his food. He seemed less nervous and required

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but little sedatives. We were anxious to get him off the avertin so on the night of the 13th it was decided not to give him any but to give him sodium amytal instead. At 9 A M, therefore, he was given three grains of sodium amytal by mouth but it did not help, so at 11 P M he was given three more grains. This did not help him either, so at 1 A M and again at 4 A M he was given $\frac{1}{4}$ grain morphine orally. *He kept asking for avertin all night long.* Next day—September 14—we did not think he was quite so well, so we decided to give him avertin again. The dose was eighty-five milligrams and was given at 9 30 P M. His blood-pressure dropped to 110/70 and his respirations were slightly more shallow than normal for thirty minutes, but were perfectly all right after that. At 1 A M, when he seemed on the verge of waking up, he was given thirty milligrams more of avertin. His blood-pressure then dropped to 105/70, but he seemed in good shape and rested well until 5 A M. He had no morphine.

Briefly, patient had avertin as follows

Sept 9 at 9 P M	70 milligrams	} 115 in the one night
Sept 10 at 9 P M	85 milligrams	
Sept 10 at 11 30 P M	30 milligrams	
Sept 11 at 10 15 P M	85 milligrams	} 125 in the one night
Sept 12 at 1 20 A M	40 milligrams	
Sept 12 at 10 30 P M	90 milligrams	
Sept 13	None	
Sept 14 at 9 30 P M	85 milligrams	} 115 in the one night
Sept 15 at 1 A M	30 milligrams	

Total amount given, 515 milligrams per kilo over a period of 6 nights 36.05 Gm

On the following day—September 15—patient seemed distinctly better and was much less nervous and needed little or no sedatives. That night, then, instead of avertin, we gave him $3\frac{3}{4}$ grains of sodium amytal intravenously at 9 40 P M, and at 11 30 P M he was given three grains of sodium amytal orally. Fifteen minutes later he got three more grains of it orally. He had some rest but did not sleep very well. By this time, though, his general condition was distinctly improved and his mental attitude had changed so that it seemed possible to bring him out of his slump. We thereupon put him on small doses of whiskey,* given every three hours, in the effort to make him drowsy. By this means it was possible to carry him along both by day and by night without much more difficulty and gradually the intervals between the doses of whiskey were lessened, while the sedatives needed were practically nil.

Following the above episode patient received an occasional dose of luminal and once in a while a little whiskey, but it was not necessary to give him any more avertin and he was completely off the morphine. His mental condition improved very much, he became much less fidgety and did not break out in the profuse sweats as formerly. His appetite became better and he went through his nights fairly well. The pain in both hands eased and the gangrenous processes of the first and second fingers of his right hand stopped at the second joint and the first joint respectively. The parts affected mummified and were later on removed. It is sad to relate, though, that the gangrenous process of his left big toe gradually, though rather painlessly, involved first the adjacent toes and then the whole foot to such extent that the leg had to be removed. (It will be noted that this is the leg that had no peri-arterial sympathectomy.) Patient went through this ordeal under avertin and gas anaesthesia quite satisfactorily and made a prompt recovery.

It was natural that concern should be had lest the successive doses of avertin have some deleterious effect but nothing of the sort was noted in the blood, the kidneys, or the liver, functional tests of the two latter being entirely normal. It was interesting, too, to note that during each day following the administration of avertin the patient was somewhat drowsy but could be roused without difficulty. Furthermore, and best of all, his appetite seemed unaffected. Indeed, as he became quieter his appetite picked up.

* Whiskey had been tried before the avertin but had not helped. •

To sum up, then, we present the case of a young man whose morale as the result of multiple extremity involvement and profound suffering over a long period of time, was so badly shattered that none of the usual methods of relieving his distress and giving him rest was of avail. In the emergency he was given successive doses of avertin over a period of six days and nights—eight doses in all, a total of 515 mg per Kg or 36.05 Gm. Upon several occasions he was given two doses, the second smaller than the first, within three or four hours. He gradually became quieter until finally it was possible to switch him over to the more usual means of dealing with such conditions. This patient suffered no harmful effects from the avertin and is now—six months later—well on the road to recovery, after having gone through a second major operation.

Naturally, it is impossible to generalize too much from one case, but the result obtained in this instance was so unexpected and startling as to warrant the hope that maybe a new method has been found to deal with conditions that have hitherto been most intractable and unsatisfactory.

BERTRAM M. BERNHEIM, M.D.

RAYMOND A. TAYLOR, M.D.

Baltimore, Md

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SIMPLE GLASS BLOOD TRANSFUSION APPARATUS

THERE are numerous apparatus for performing blood transfusions. However, the illustrations below present a very simple, inexpensive apparatus already available as an importation from Japan where it is used for other purposes. It consists of a simple Y-shaped glass adapter (Fig 1) with a ground-in glass valve in each arm making a ball-valve arrangement. The glass valves in each arm of the Y-adapter open and close by suction and pressure respectively as the piston of the syringe is pulled out or pushed in. On the upstroke the action automatically opens the valve from the donor and closes the valve to the recipient and conversely on the downstroke closes the valve from the donor and opens the valve to the recipient. The valve arrangement is airtight and leak-proof so that there is no reflux or possibility of admixtures of blood. The adapter is made of transparent glass so that the entire procedure is constantly visualized. Each extremity is bulbous so that rubber tubing may be fitted over it. Any size Luer syringe may be used with the adapter, but the medium-sized ten-cubic centimetric syringe has been found the easiest to handle.

This apparatus greatly facilitates the giving of blood transfusion without the use of saline. It is desirable during the transfusion to spray ether on the syringe and glass adapter. This delays clotting and prevents the piston of the syringe from sticking. The syringe is preferably changed after the transfusion of 200 cubic centimetres of blood. The bi-valve glass adapter does not stick

BRIEF COMMUNICATIONS

during a transfusion of 500 cubic centimetres of blood. For larger transfusions it is better to insert a new glass valve apparatus.

The materials and apparatus are prepared for blood transfusion according to the method published by Lewisohn and Rosenthal¹. This provides for the special cleansing of the apparatus to remove old blood and eliminate foreign protein.

A slight modification of the apparatus (Fig. 2) is particularly valuable for infusion of intravenous solutions, such as 50 cubic centimetres of 50 per cent glucose, saline, or solutions for local anaesthesia.

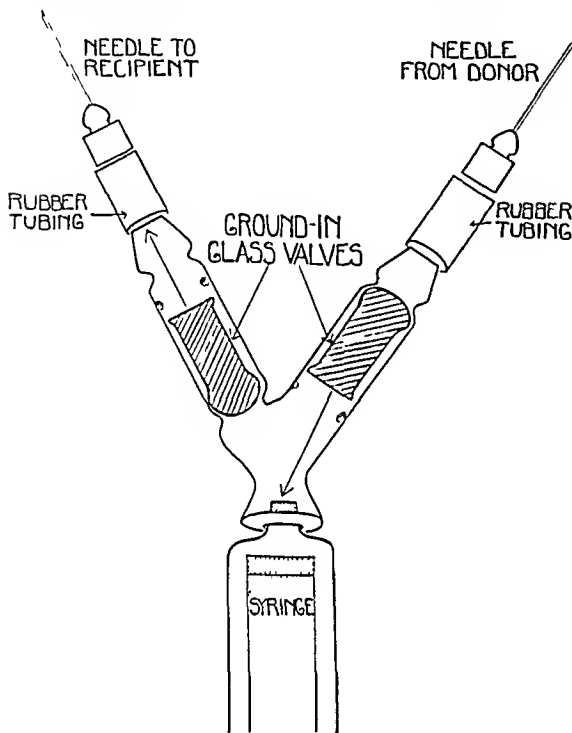


FIG. 1—Set up for transfusion

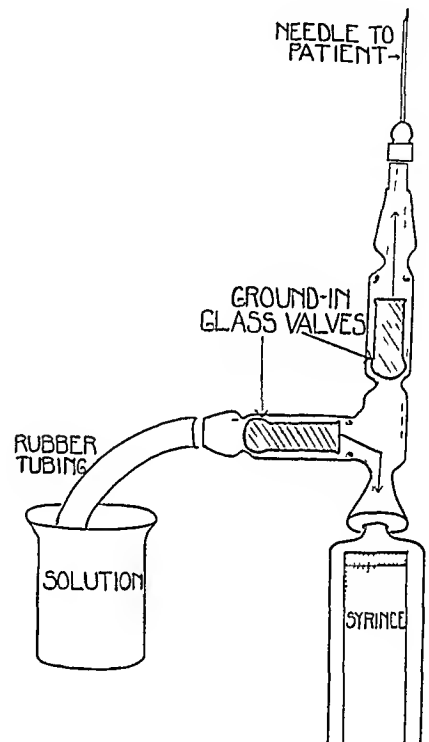


FIG. 2—Set up for infusion

A small syringe may be used for this purpose to insure a continuous flow without detaching the syringe to draw up additional solution. A desirable feature is the grounding of one extremity so that a needle may be attached directly to it. This modification is also very desirable for the withdrawal of body fluids, as in a thoracentesis or aspirating a gall-bladder or cyst at the operating table. For this purpose the arrangement of the valves is reversed.

There are several advantages in the use of this universal bi-valve glass adapter: (1) The ease in setting up for transfusion and simplicity in operation due to automatic action. (2) The adaptation for thoracentesis, paracentesis, and infusions. (3) A more or less continuous flow of fluid with any size Luer syringe. (4) The low cost.

SIDNEY HIRSCH, M.D.,
New York, N. Y.

¹ Lewisohn, R., and Rosenthal, N. Prevention of Chills Following Transfusion of Citrated Blood. JAMA, vol. 100, pp. 466-469, February 18, 1933.

EMBOLECTOMY REPORT OF TWO ATTEMPTS ON THE SAME PATIENT

IN THE ANNALS OF SURGERY of July 1932 the writer reported an unsuccessful embolectomy performed on a woman, aged sixty-four with an embolus involving the left femoral artery. The present report is intended to show that the operation of embolectomy may fail to cure the patient even when performed soon after the supposed lodging of the embolus.

J S., male, aged forty-five carpenter with negative past history except for a mild diabetes mellitus of eight years' duration was admitted to the Billings Hospital March 11, 1932, on account of pain in the left arm and cyanotic discoloration of the arm almost up to the elbow of eighteen hours' duration. The onset was sudden with acute pain in the arm and hand not relieved by massage. Five days before admission the patient had a cough with hæmoptysis and generalized chest pain. Examination revealed cardiac enlargement associated with a diastolic murmur. There was a friction rub in the right posterior pulmonary base. The left arm was markedly discolored to within six centimetres of the elbow and skin temperature and skin sensation tests indicated that this was the point of maximum change. The left leg was a little colder than the right and the dorsalis pedis pulsation was weaker on the left than on the right. The coagulation time was two and one-half minutes and the bleeding time one and one-half minutes.

Two hours after entrance the artery was opened in the axilla under local anaesthesia. By probing upward fifteen centimetres an embolus, two centimetres long, shot forth followed by a gush of blood. The radial pulse did not return nor was there any change in the appearance of the arm so a second arteriotomy was made in the cubital fossa and another clot removed. There was still no change in the appearance of the arm and it was assumed that the operation was done too late and that thromboses filled all the smaller arteries. Complete mummification to the elbow required amputation at the middle of the humerus on March 28. Pathological examination revealed no arterial disease.

On March 18 there was numbness and tingling in the left foot of sudden onset. The foot was blanched and cold, all sensation was lost over the toes and sensation to touch was lost over the sole of the foot. Skin temperature tests showed the point of maximum change to be at mid-calf. Operation was performed two hours later under local anaesthesia. Arteriotomies were made in the popliteal artery and in the posterior tibial artery just above the internal malleolus. Clots were removed from both places, but arterial flow was not restored. The next day the foot was blue and on April 13, the leg was amputated at the junction of the middle and lower thirds of the tibia. The stump became infected and *Bacillus welchii* obtained, but there was no crepitation. The leg was amputated at mid-thigh on April 15 and the next day the patient died with a temperature of 41.6°C. The anatomical diagnosis was thrombosis (both organized and recent) of the circumflex branch of the left coronary artery with extensive infarction and atrophy of the myocardium of the left ventricle, marked fibrous replacement of the myocardium of the left ventricle, parietal thrombus over the infarct in the left ventricle, peripheral arterial thromboses with infarction of the spleen, kidneys and lower lobe of the right lung, healed amputation stump of the left arm, open amputation stump of the left leg.

Histological examination of the kidney infarct indicated that it was at least six months old. The pulmonary infarct was probably the cause of the hæmoptysis. Although the patient never had symptoms in his leg until two hours before the second operation, examination a week before indicated circulatory deficiency. This may have been due to small emboli preceding the final one or to thrombosis, but it is interesting to note that without this oppor-

tunity to examine the leg a week before the probable circulatory weakness would never have been suspected. None of the arteriotomies were done on vessels not already occluded and as they were all done under local anæsthesia, it is probable that they neither hastened the impending gangrene nor endangered the life of the patient. During the operations it was noticed that the blood clotted faster than normal even though the pre-operative and post-operative coagulation times were normal. It is probable that the coagulation time alone is not the real index of intravascular coagulation tendency as has been shown recently by Bancroft.

Bull¹ found 181 instances of parietal cardiac thrombi in a series of 6,140 necropsies and the present case is an instance of multiple embolism from one of these thrombi. Recent reviews of the subject of embolectomy by Danzis² and by Pearse³ confirm the belief that the majority of emboli lodging in peripheral vessels are cardiac in origin.

The probable endogenous *Bacillus Welchii* infection is of interest. Andrews recently has reviewed the literature on this subject and called attention to the frequent presence of this organism in normal tissues.

HENRY HARKINS, M. D.
of Chicago, Ill

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MEMOIRS

ALEXIS VICTOR MOSCHCOWITZ

1865-1933

ALEXIS VICTOR MOSCHCOWITZ came to America from Hungary when a boy of fifteen. Industry and enthusiasm were ever prominent in his per-



ALEXIS VICTOR MOSCHCOWITZ M.D.

sonality. He was graduated in pharmacy in 1885 and then entered the College of Physicians and Surgeons, Columbia University. On receiving his

degree in 1891, he was awarded one of the Harsen Prizes for distinguished scholarship. Later he became Professor of Clinical Surgery to his Alma Mater.

His first post-graduate position was that of interne in the German Hospital of New York, now the Lenox Hill Hospital, where he gained the confidence and friendship of those with whom he worked. After a short period in general practice he became the Associate of the late Doctor Langmann and also of that progressive surgeon, Willy Meyer. In 1895 he secured a place in the out-patient department of Mount Sinai Hospital from which it was but a stepping stone to an appointment as Adjunct under Dr Arpad G. Geister. He reached the rank of full Attending Surgeon in 1914.

His originality and faithfulness carried him far toward the high places in his profession. He became Consulting Surgeon in 1927, an office which he held for the remainder of his life. Other institutions sought his professional skill and he became attached to several in the capacity of Attending or as Consultant.

A Fellow of the International Surgical Association, he enjoyed to the full the cordial friendships which he made with surgeons from many countries. In 1927, he was made a Fellow of the Royal Academy of Physicians of Rome. Mrs. Moschcowitz invariably accompanied him to the Congresses and by her gracious and congenial presence added greatly to the pleasure of the social functions.

To enumerate by then title all the notable contributions made by Moschcowitz would far exceed the limits of this memoir. There was scarcely a field to which he did not contribute. His name is especially distinguished as an expert in hernia. A monograph by him on this subject was published in Johnson's Operative Surgery, which has long been considered authoritative.

The final addition to his works was the paper on Vestigial Mastitis read before the American Surgical Association at the meeting of 1933. It is a piece of scientific, clinical and literary investigation which cannot fail to link his name with the disease which he described.

During the war, Alexis Moschcowitz was appointed by the Surgeon General to the Empyema Commission where he did outstanding service in research as well as in the operating rooms of many of our military hospitals. His abounding patriotism appeared to bring him as much gratification and pride in the title of Colonel in the Army as his many honors in civil life. Soon after the war (on December 12, 1919), Doctor Moschcowitz by invitation of the College of Physicians of Philadelphia delivered the Mutter Lecture before that body.

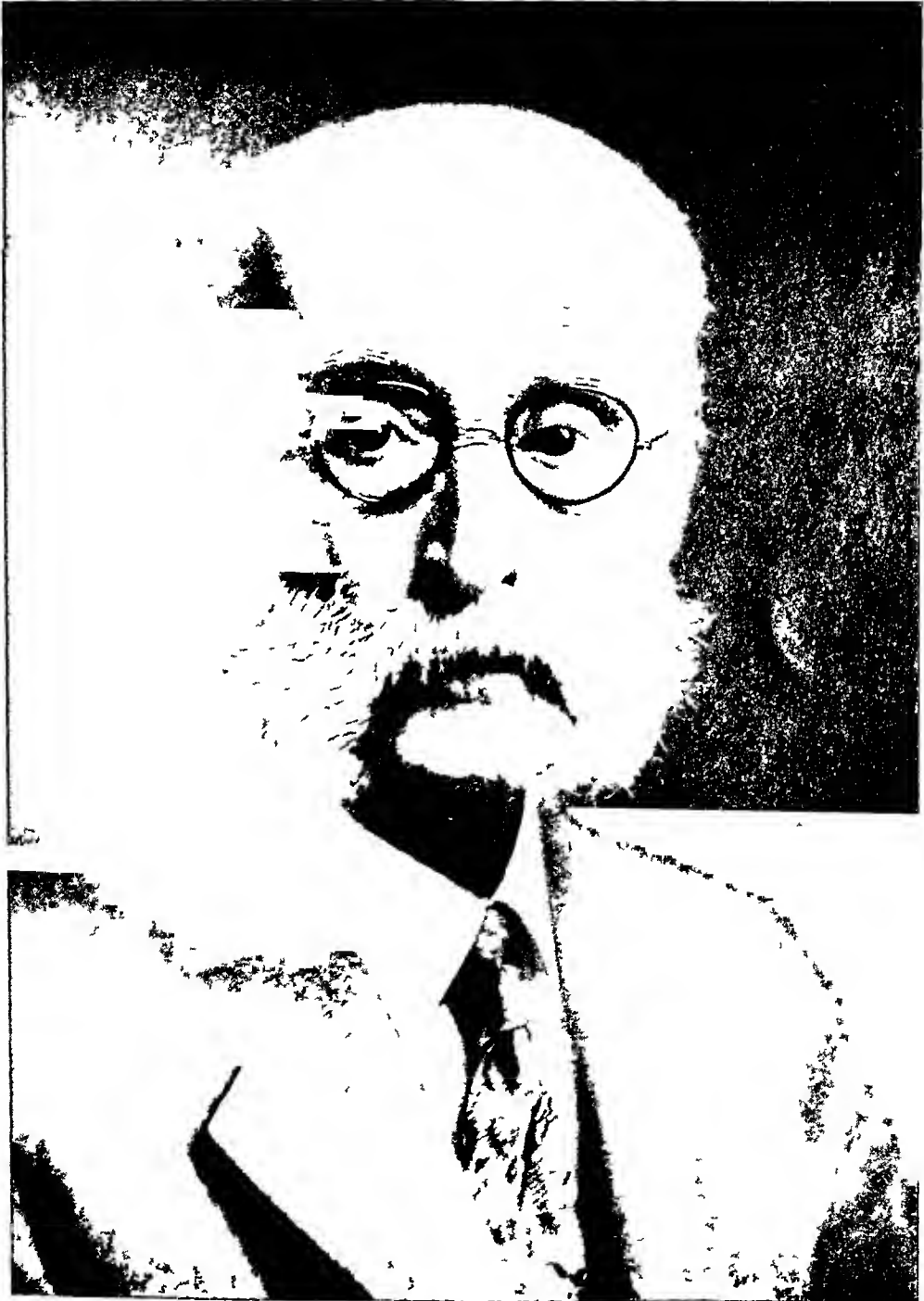
At Mount Sinai Hospital, where I knew him best, he held the affection and respect of everyone—the trustees, his colleagues, the nurses—all who served with him in any capacity. He will always be remembered with affection for his gentle ways, his friendly smile and a certain whimsical humor which made all his companions prepare for something wise and witty whenever he rose to speak.

HOWARD LILIENTHAL, M.D.

MILES FULLER PORTER

1856-1933

MILES FULLER PORTER was born September 27, 1856 His father was a surgeon in the Union Army and the war orphaned him at an early age, making his later education dependent largely on his own exertions It was these youthful struggles that developed one of his most marked characteris-



MILES FULLER PORTER, M D

tics, that of self-reliance It was not easy for him to change or to admit that he had been mistaken His early orphanage also bred in him a habit of industry He was never idle From early childhood he knew what his vocation would be and every effort was bent toward attaining that goal He was

MILES FULLER PORTER

graduated from the Ohio Medical College in 1878. He was in love with his profession, and it was this absorbing interest that made him regular in his attendance on medical society meetings, and ready to defend his opinions on any subject on the floor. In debate he was a forceful speaker because he spoke from a wide experience, and had implicit confidence in his own judgment.

He attained membership in all the leading Surgical Associations. He served his county and state organizations as president and became a trustee of the A M A from 1900 to 1909.

The writer's professional association with Doctor Porter dates from 1891, when he was doing a prodigious amount of work in general practice. It was always a matter of surprise that one so frail-looking could endure the loss of so much sleep. Nearly all of his early surgery was recruited from his own patients, but gradually more and more of his surgical cases were referred by other physicians until in 1899 he found it necessary to limit his practice. This gave him more time to devote to study and the preparation of papers for publication. For a number of years he edited the department of surgery in the Fort Wayne Medical Magazine which later became the Journal of the Indiana State Medical Association.

It may truthfully be said of Doctor Porter that he was a self-made man for although he yearned for the opportunity to perfect himself by study abroad in his younger years, the demands of a large and growing family made this impossible. He did manage to see some of the London and Edinburgh hospitals while recuperating from an illness resulting from overwork.

His code of morals was very strict. He gave to his patients the best service of which he was capable without regard to recompense. He was ardent in his condemnation of every act that might be construed as at all dishonest, or not open and above-board.

Doctor Porter's home life was ideal and he could always be found there when not engaged professionally. To those who did not know him well he was often regarded as austere and difficult of approach, whereas the exact opposite was the truth. He was ever ready and willing to make any sacrifice for a friend.

He bore his last, long, painful illness with fortitude and maintained his interest in medicine to the end by contrasting published accounts of his malady with the progress his own case made to a fatal termination on Dec 6, 1933.

Like Osler, "he was only sorry he could not attend the post-mortem."

BUDD VAN SWERINGEN, M D

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THE KLIPPEL-FEIL SYNDROME*

BY DEFOREST P WILLARD, M D , AND JESSE T NICHOLSON, M D

OF PHILADELPHIA, PA

THE Klippel-Feil syndrome originated from a case report by M Klippel and A Feil in 1912. They formulated the following conditions: (1) Limitation of head motion; (2) Low margin of head hair; (3) Absence of neck. They believed the etiology was intra-uterine inflammation or trauma. Their subject was a forty-six-year-old male, a tailor by trade. At necropsy they found the cervical vertebræ fused and having a posterior spina bifida occulta. The mass did not contain either axis or atlas and was thought to be formed by dorsal vertebræ as there were four pair of ribs, and but eight normal dorsal vertebræ below it.

In 1919, Feil expressed a belief that the high spina bifida was the original lesion and that pressure and trauma later in foetal life caused the fusion and malformation. He recognized three types: (1) Complete absence of cervical spine; (2) partial numerical reduction of cervical vertebræ; and (3) associated partial reduction extending throughout the spine.

An earlier report of this syndrome was by J Jackson Clarke, in 1906, before the Clinical Society of London. He reported a male four years of age with head fixed, with chin close to sternum and no movements of cervical spine. He stated, "skiagrams showed extensive abnormalities in the form of bones in the upper dorsal and cervical regions, and a cervical rib was present on each side." He claimed operative treatment followed by massage gave natural movement. There was, however, no report of the operative procedure.

The two cases that we will report fall into the second group of Feil's classification: the first case by actual numerical reduction of vertebræ, and the second case by reduction of vertebræ due to fusion.

CASE I—J S, a male, aged eight years, was the sixth of seven children (Figs 1 and 2). There were no existing abnormalities in the other members of the family. He had a normal birth at eight months. His deformed neck was noticed in the second week. He was weaned at five months. He had no serious illnesses. He is under-nourished and under-developed. His head rests low between his shoulders, the hair line is low on the neck, there is marked nuchal depression. He has a rounded dorsal kyphosis. His trapezi flare out from the base of his skull to his shoulders. His scapulæ are elevated. His chin rests close to his sternum. His nipples are relatively low. Flexion and extension of his head are practically normal. Rotation is possible to 25° in either direction. Lateral flexion is somewhat limited. All motions of the neck are without pain. There is bimanual synkinesia or associated movements of the hands. Scratching, patting and writhing motions are carried out by the opposite hand with mirror-like precision. Reflexes are normal. His teeth have serrated edges. The two lateral

* Read before the Philadelphia Academy of Surgery, May 2, 1932

upper incisors are unerupted and the two lower lateral incisors are behind the middle incisors. There are no other gross abnormalities. The Mantoux Tuberculin Test and blood Wassermann are negative.

The Rontgen film shows but six cervical vertebræ with fusion between the bodies of the first and second and partial fusion with the third. The spinous processes of the second and third vertebræ are united as are those of the fourth and fifth (Fig 3). There is a posterior spina bifida occulta of the third and fourth vertebræ (Fig 4). The other spinal vertebræ are normal except for the first sacral which shows a posterior spina bifida occulta.

CASE II—S. W., a male, aged ten years, was the second in four children. His mother was an epileptic, but there were no other abnormalities in other members of the family. His past history was essentially negative. His deformity was not observed until his second year.

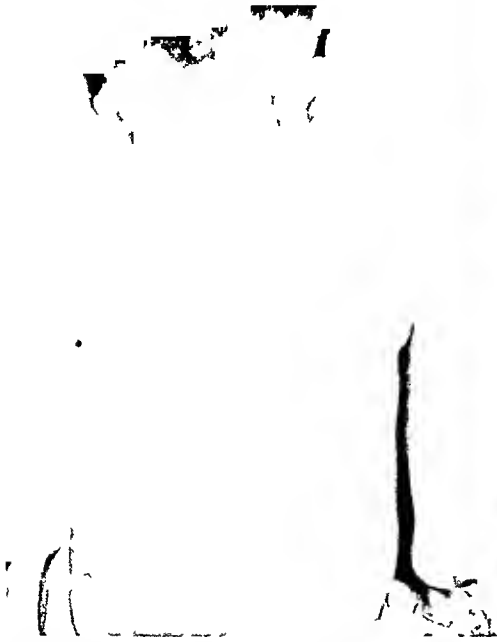


FIG 1—(Case I) J. S. Head in flexion. Note low hair line, short neck, nuchal depression, winged trapezoid, high scapulae.



FIG 2—(Case I) J. S. Showing prominent occiput, dorsal kyphosis.

He presents similar gross characteristics of the other case, but has a slight tendency toward a right torticollis. Rotation of the head is limited, other motions about normal. He does not have bimanual synkinesia. His von Pirquet test is positive, but blood Wassermann negative.

The Rontgen film shows seven cervical vertebræ with fusion of the first and second, and third and fourth vertebral bodies, with fusion of the spines of the second and third, and sixth, seventh cervical and first dorsal vertebræ. There is no spina bifida occulta (Fig 5).

Etiology—Of the sixty cases in the literature all have occurred spontaneously without history of familial malformations. The syndrome has occurred with about equal frequency in both sexes. De Beaujeur and Block

and also Ingelians and Piquet have reported hereditary syphilis as a factor. Both of these cases were deaf-mutes with mental deficiency. In the majority of reports syphilis was not questioned. Trauma has been mentioned as an explanation. The developmental deviations which take place before the third month of embryonic life are undoubtedly of influence.

Embryology—Jameson claims that ossification begins in the seventh week of foetal life in the spinal arches and the tenth week in the bodies. Before the third month of development, therefore, distinct cervical characteristics essential to the shape of the adult osseous cervical vertebrae have occurred.

According to Bardeen, there are two bilaterally placed centres of chondri-

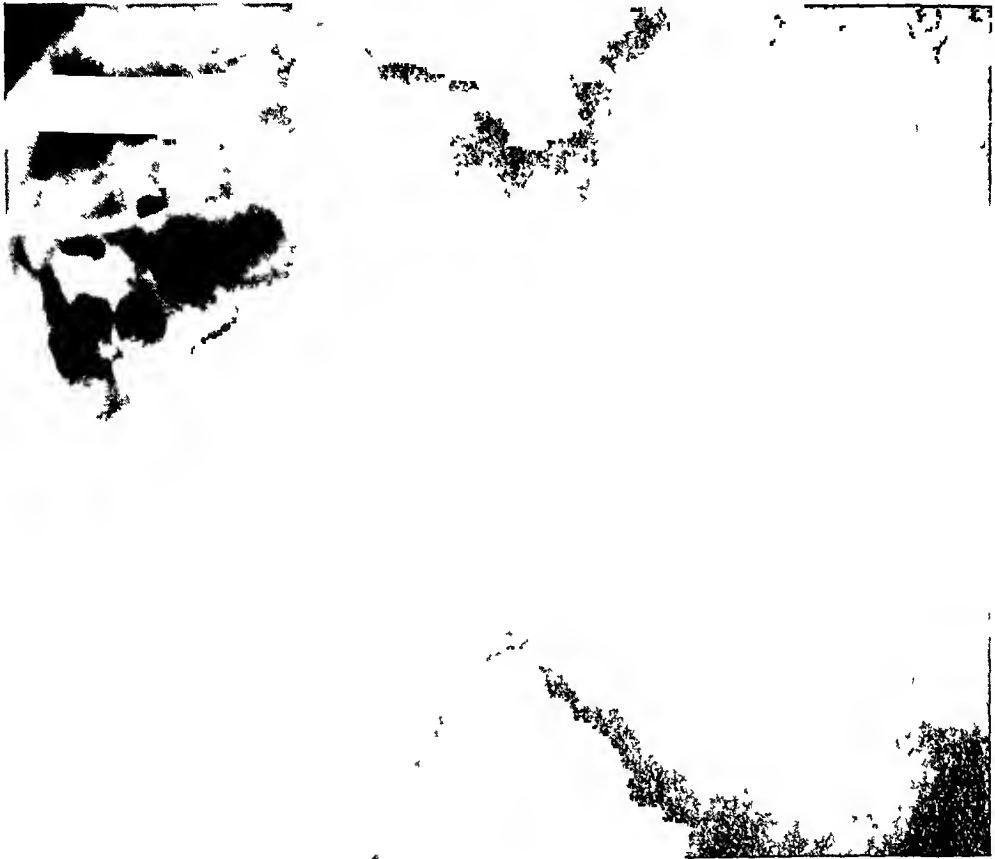


FIG. 3—(Case I) J. S. Six cervical vertebrae, fusion of first and second cervical bodies and fusion of spinous processes of second third and fourth and fifth.

fication for each of the vertebral bodies. Ventral fusion takes place before dorsal fusion. There are separate centres of chondrification for the neural processes from which develop the laminae, articular and transverse processes.

The odontoid process represents the body of the first cervical vertebra. During the second month there is chondrification of the arches of the more cranial cervical vertebrae, at which time the atlas is fused to the axis and for a brief period, the bases of the neural arches of the axis and atlas, together with the tissue forming the occiput bone, become fused into a nearly continuous mass of pericartilage.

It appears that the malformation is determined before the third month of foetal life. The posterior spina bifida is caused either by the later fusion

of the posterior chondrification centres for the vertebral bodies, or by the lack of fusion of the laminae chondrification centres. Due to faults in these laminae chondrification centres, fusion of adjacent spinous processes occur. The apparent or actual reduction of cervical vertebra is brought about by faulty or complete fusion of the body chondrification centres in forming the continuous mass of pericartilage with the occiput. An extension of this abnormal fusion probably accounts for the changes which may appear in the upper dorsal region.



FIG. 4.—Posterior spina bifida occulta of the third and fourth cervical vertebrae

Pathology—The following additional variations occur in the reported cases of Klippel-Feil syndrome. (1) Usually fusion of atlas to occiput (Heudecker). (2) Fusion of first three vertebral bodies with fusion of spines of third, fourth and fifth cervical vertebrae (Guillain and Mallaret). (3) Fusion of the first and second cervical vertebrae with third intact and fourth, fifth and sixth fused (Pierre Ingelians). (4) Fusion of third, fourth, fifth and sixth cervical bodies and fusion of sixth and seventh cervical

and first and second dorsal spinous processes (Elouson) (5) Reduction to four cervical vertebræ. (Lavastine and Miger) (6) All cervical vertebræ fused in one mass with four cervical ribs and reduction of dorsal vertebræ to eight. (Klippel-Feil) (7) A posterior spina bifida occulta which may extend from occiput to thorax (Nobel and Frawley) (8) Fusion of six upper dorsal vertebræ. (Pytel and Saevic) (9) A fusion of first and second right ribs and two ribs arising from the fourth left dorsal vertebra (Ingelrans and Piquet) (10) Fusion of the fifth lumbar and sacrum (Ingelrans and Piquet) (11) Dorsal spina bifida occulta and sacral rachichisis (Ingelrans and Piquet.) (12) Oblique bodies of cervical dorsal vertebræ with a hemivertebra and unfused laminae. (Ingelrans and Piquet)

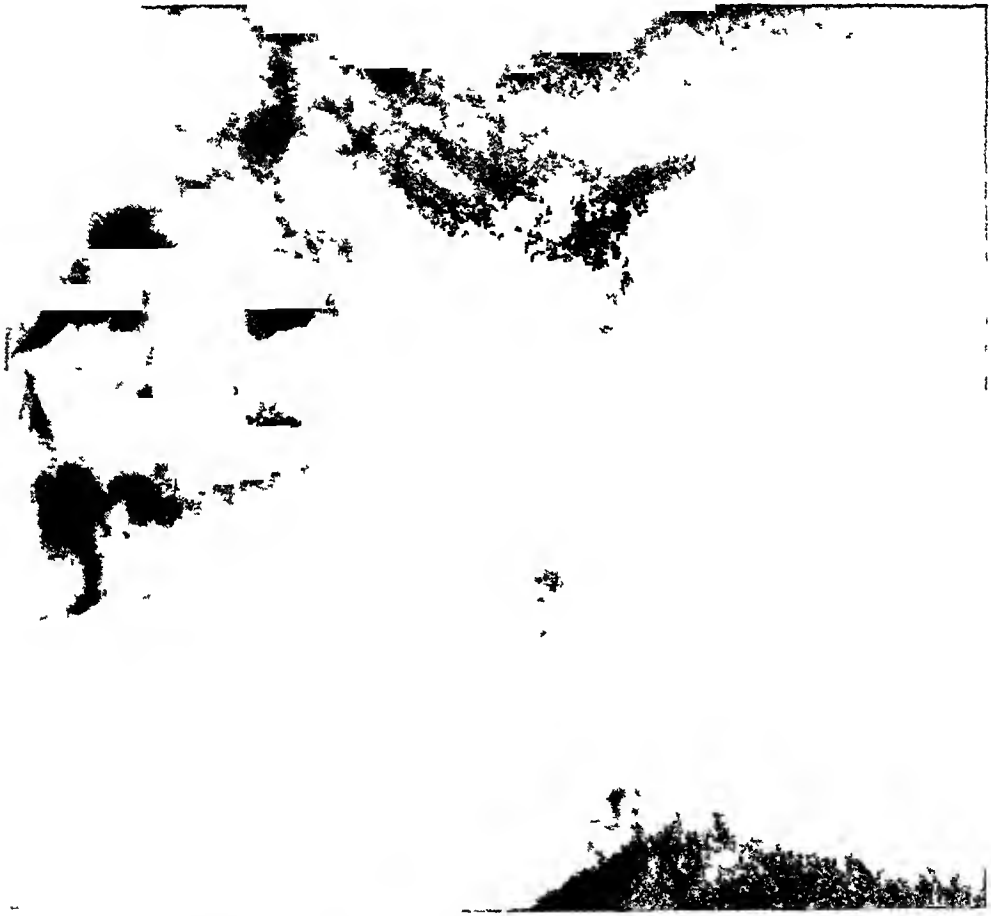


FIG 3—(Case II) Fusion of first and second and third and fourth cervical bodies with fusion of the spaces of the second and third and sixth and seventh cervical and first dorsal vertebrae

Symptoms—The physical characteristics are the apparent absence or shortness of neck the low hair line on the back of the neck the nuchal depression the flaring trapezium the high position of the shoulders the prominence of occiput the dorsal kyphosis the high scapulae the proximity of chin to sternum the low nipple line the limitation of head motion and freedom from pain

The associated variations may be torticollis asymmetry of face scoliosis Sprengle's deformity (Heidecker) absence of external auditory meatus (Ingelrans and Piquet) abnormalities of upper extremities—atrophy of left

forearm and hand (Pytel and Saevic), club hand (Ingelrans and Piquet), mental debility (de Beaujeur and Block), bimanual synkinesia or mirror movements (Bauman)

Diagnosis—The cases may readily be mistaken for tuberculosis of the cervical spine. The differential diagnosis depends upon, first, the absence of rigidity, second, motion without pain, third, Rontgen film

Treatment—Heidecker states improvement in mobility after gymnastic exercise. Ryerson cites improvement in cosmetic effects in one case after division of the trapezius. Certainly, massage and stretching should be given a thorough trial early in the growth period and the associated deformities of torticollis, scoliosis, club hand, *etc.*, corrected

Prognosis—Guillain and Mollaret describe a case, male, thirty-three years old, who developed a progressive spastic paralysis starting in the right leg and involving the left side twelve years later. Heidecker reports pain in old age due to plexus disturbances. All cases, however, which have come to necropsy have died of an acute infection. About fifteen adult cases have been reported. The oldest was seventy years.

Discussion—There is no description of the cervical nerve abnormalities which would be expected with reduction and fusion of cervical vertebræ. There are few neurological symptoms reported. Bauman reported mental retardation, spasm of cervical muscles in two cases, and difficulty in swallowing or breathing in one case, and "mirror movements"

There are no previous accounts of these observations except mental retardation in two cases of mutism and hereditary syphilis. Our first case shows "mirror movements" or bimanual synkinesia. Purves-Stewart states that this may be physiological, especially in children, occasionally persisting into adult life. Rarely, it may be familial and is then regarded as a stigma of a neuropathical inheritance. Badgley points to imitative synkinesia in hemiplegics, voluntary movements of one side of the body tend to be reproduced symmetrically on the hemiplegic side. It, therefore, appears that the associated movements are extra-pyramidal in origin and are not caused by any abnormality in the cervical region.

CONCLUSIONS

(1) The Klippel-Feil syndrome is a developmental abnormality dating from the third month of foetal life.

(2) Syphilis is incidental rather than etiological.

(3) Additional variations in other spinal vertebræ frequently occur.

(4) Other congenital abnormalities co-exist.

(5) Cases may be mistaken for cervical Pott's disease.

(6) The treatment is palliative.

(7) The deformity is not detrimental to longevity.

(8) "Mirror movements," bimanual synkinesia, are not characteristic of the condition.

THE KLIPPEL-FEIL SYNDROME

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HISTAMINE THERAPY OF RHEUMATIC AFFECTIONS AND DISTURBANCES OF THE PERIPHERAL CIRCULATION

BY DAVID H. KLING, M.D.
OF NEW YORK CITY

IN 1931, D. Deutsch¹ reported very favorable results in 250 cases of painful affections of muscles and joints treated by galvanic cataphoresis of histamine over the affected parts. His findings were corroborated by Kopits,² Thrumpp,³ v. Papp,⁴ Friedlander,⁵ Payer,⁶ and supplemented recently by Vas⁷ and Bettmann.⁸ Failures of this method reported by Ruhmann⁹ and Kaufmann¹⁰ were plausibly explained by faulty technique.

No report in American literature has appeared as yet. This preliminary paper will therefore give an outline of the principle, the modalities and the temporary results of histamine treatment in rheumatic affections.

The Principle of the Action of Histamine on the Peripheral Circulation—Recent investigations have emphasized the significance of disturbance of the peripheral circulation in the etiology of chronic affections of joints and muscles. Goldhaft, Wright and Pemberton¹¹ have produced osteo-arthritic changes in the knee-joint of the rabbit by interference with the normal blood supply. Spasm of the arterioles provokes myalgia, according to v. Papp. The elimination of the vasoconstriction by ramisection and sympathetic ganglionectomy gave good results in selected cases of rheumatoid arthritis, published from The Mayo Clinic by Hench, Henderson, Rowntree and Adson.¹²

Also, physiotherapeutic procedures produce beneficial effects in rheumatic affections chiefly by a temporary increase of the blood supply. According to Lewis,¹³ every irritation liberates in the tissues a histamine substance which he regards as the hormone regulating the peripheral circulation. Deutsch conceived, therefore, the idea to supply directly the affected parts with histamine and thus overcome a possible deficiency more efficiently than by the usual physiotherapeutic measures.

A simple experiment demonstrates the powerful influence of histamine on the peripheral circulation. A drop of 1 to 1000 histamine solution is placed on the skin, which is subsequently pricked by a sharp needle. Within five minutes an urticaria wheal develops surrounded by a red flare. The response of the peripheral circulation consists of a triple reaction: first, there is a local dilatation and an increase in the blood flow in the minute vessels (purple spot); second, a local increase in the permeability of the capillaries, which produces the wheal; third, a widespread dilatation of the surrounding arterioles (flare).

The distribution of histamine over the affected part in rheumatic conditions will therefore result in a comprehensive alteration of the peripheral circulation in the diseased parts.

Technic of the Histamine Application—(a) *Cataphoresis*—Deutsch devised for this purpose a special galvanic apparatus and used leaf impregnated with histamine in conjunction with it. This outfit, called Katexon and Katexon leaf, is not yet available here. The following technic was therefore adapted. A reliable galvanic apparatus equipped with an accurate milliammeter supplies the electric energy. For electrodes aluminum or lead leaf is used. Filter paper or gauze is moistened with a solution of histamine acid phosphate of 1 to 1000, dissolved in 0.1 per cent chloretone for preservation. The affected part is covered by the filter paper, over which the positive electrode is adjusted and secured with rubber bandages. On account of the danger of producing burns, care must be taken so that the electrode should not touch the bare skin and all metal should be removed from the vicinity of the current. A very convenient negative electrode consists of a non-metal basin filled with weak saline solution. A strip of lead leaf connected with the positive pole is adopted to the bottom of the basin and covered with a rubber sheet. One hand is submersed in the basin of saline. The current is slowly built up from four to eight milliamperes, allowing about one milliampere to the square inch of positive electrode. It is permitted to act from one to two minutes.

In the majority of cases, no more than a prickling sensation is felt over the treated part. The current is gradually decreased. Contact should not be interrupted suddenly.

The sequence of effects of the histamine cataphoresis was studied on patients and in self experiments. The exposed skin appears reddened immediately after removal of the positive electrode. Soon wheals crop up and blend into one patch of urticaria, which stands out whitish from the surrounding erythema (Fig 1). The temperature over the treated parts is raised from 2° to 3° C. Gradually, the elevation of the skin recedes, leaving red spots. The skin does not return to its normal appearance before five to six hours.

Bettmann has studied the capillary changes and found a marked increase in the rate of circulation and in the number of capillaries visualized and dilatation of the subpapillary vessels. He demonstrated the marked influence on resorption experimentally on the skin of rats, subjected to cataphoresis of 10 per cent sodium iodide solution with preceding histamine application. Controls treated only with iodine cataphoresis showed in the section particles of iodine precipitated with thallium acetate in the superficial layers of the corium, while the sections of the skin which were subject to preceding histamine cataphoresis showed iodine particles scattered through all layers. Another evidence of the effect on deep vessels of the histamine was furnished by Zsedenyi and quoted by Kopits. After ligation of bleeding vessels, in the course of an operation, histamine was applied to the skin adjoining the incision. Thereupon fresh bleeding occurred from deep small vessels. This permitted an exact hemostasis.

(b) A modification of the histamine cataphoresis was recently published by Bettmann.

A non-metallic (glass, enamel) basin is filled with a 1 to 10,000 solution of histamine and connected with the positive electrode and insulated by covering it with rubber sheet. The affected extremity is submersed in the histamine solution. The negative electrode is wrapped in insulating material (linen, towels or rubber) and applied as a cuff above the treated part. The current is permitted to act for five to ten minutes. This method is very convenient in affections of the hand and foot. Drawbacks are the large amounts of fluid necessary and frequent renewal as the solution deteriorates in from one to three days. The reaction, also, is not so strong as with the former method.

(c) *Scratch Method*—In cases where galvanic apparatus was not at hand I have used the following method of application of histamine. The skin is

cleansed with gasoline or ether, with a sharp pointed instrument deep scratches are drawn over the affected area in vertical and horizontal directions at intervals of one-fourth of an inch. The whole area is thus divided into small squares. A piece of gauze is saturated with the 1 to 1000 histamine

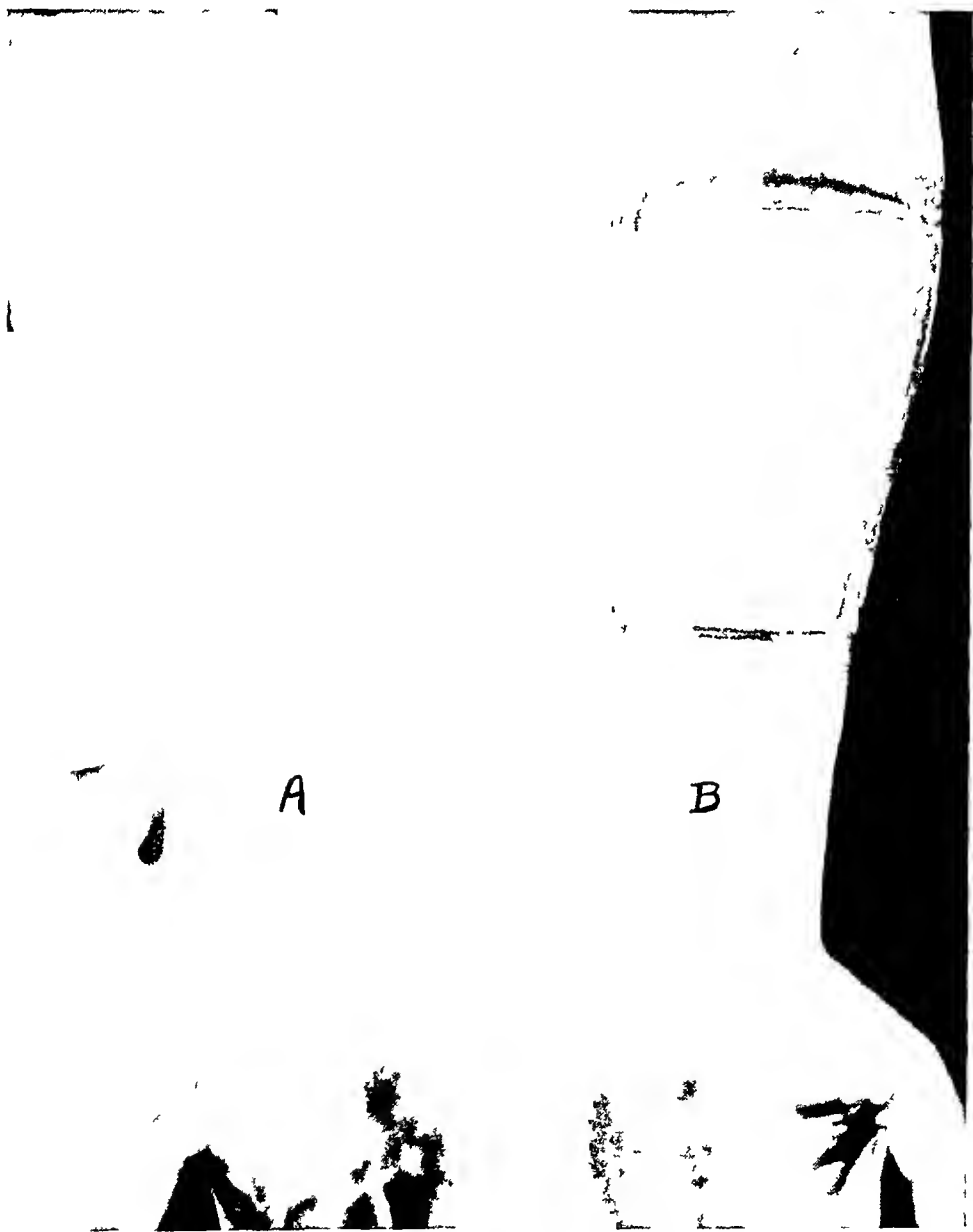


FIG 1—Histamine application (A) Scratch method, squares formed by strips of urticaria (B) Cataphoresis, a continuous patch of urticaria, outlined with charcoal

solution and rubbed into the scratches. Soon erythema appears and stripes of urticaria develop corresponding to the scratches (Fig 1-A). The changes on the skin and the therapeutic effects are equal to the ones observed with the histamine cataphoresis. The advantages of this method are simplicity and time-saving. It is also of value as it proves that the action of histamine is

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independent from the electrical current, thus it refutes the contention of Kaufmann that the analgesic effect of this treatment is due to the action of the positive pole upon the tissues. Disadvantages are the persistence of the scratches for about a week and it is therefore only used on covered parts.

TABLE I

Summary of Histamine Therapy Results

Diagnosis	No Cases	Cured or Improved	%	Failed	%	Recurred	Remarks
Myalgia	316	301	95.6	15	4.4	26*	*out of 151 cases
Static and traumatic myalgia	34	31	91.1	3	8.9		
Contractures	29	20	69.0	9	31.0	16	
Joint affections	94	85	91.3	9	8.7	21*	*out of 56 cases
Acroparesthesia	20	18	90.0	2	10.0		
Neuralgias	32	23	71.8	9	28.2	3*	*out of 13 cases
Miscellaneous	29	29	100.0	0	0.0	5*	*out of 10 cases
Totals	554	507	90.8	47	9.2	71*	*out of 230 cases

Indications and Therapeutical Results—Table I presents a compilation of the available data on histamine treatment of rheumatic conditions. Out of a total of 554 cases, 507 (90.8 per cent) were either cured or improved, forty-seven cases (9.2 per cent) were not benefited. However, in a series of 230 favorable cases, reported by Deutsch and Kopits, the relief was only

TABLE II

Analysis of Results of Histamine Therapy

Condition	Author	Total Cases	Cured or Improved	%	Failure	%	Recurrence	%
Myalgia	Deutsch	94	89	95.7	5	4.3	14	16.7
Myalgia	Thrumpp	100	98	98.0	2	2.0		
Myalgia	Kopits	57	56	98.2	1	1.8	12	21.4
Myalgia	Vas	45	40	88.9	5	11.1		
Myalgia	Kling	20	18	90.0	2	10.0		
Traumatic myalgia	Deutsch	6	6					
Static myalgia	Vas	28	25	89.3	3	10.7		
Neuralgia	Deutsch	3	0	0.0	3			
Neuralgia	Kopits	13	9	69.3	4	30.7	3	33.3
Neuralgia	Vas	16	14	87.5	2	12.5		
Arthralgia	Deutsch	4	4					
Arthralgia	Kopits	3	3					
Chronic arthritis deformans	Deutsch	23	20	87.0	3	13.0	2	10.0
Chronic arthritis deformans	Kopits	10	10	100.0	0	0.0	5	50.0
Poliarthritis	Deutsch	16	14	87.5	2	12.5	14	100.0
Joint diseases	Vas	38	34	84.5	4	10.5		
Acroparesthesia	Vas	20	18	90.0	2	10.0		
Contracture	Kopits	29	20	69.0	9	31.0	16	90.0
Miscellaneous		29	29	100.0	0	0.0	5	

temporary in seventy-one (30.9 per cent) cases. This high percentage of recurrences was partly due to insufficient treatment in the experimental stage of the method, and to its application in conditions where only symptomatic effect could be expected. On the basis of Table II, which gives a survey of the results by each author, the present status of this treatment will be analyzed.

Myalgia (Myositis)—Three hundred sixteen cases, representing over 56 per cent of the total, belong to this group. Pain, tenderness and limitation of motion due to muscle spasm are the chief symptoms. Sometimes distinct hardening can be palpated within the muscle in the vicinity of the insertion (Myogelosis). The onset is rather acute and frequently provoked by exposure to temperature changes or by prolonged exertion of the muscle group. The short time since introduction of the histamine treatment permits an evaluation of the effect only in relatively acute conditions which present a definite yet simple clinical picture. This explains the prevalence of the reports to date in painful affections of the muscles.

For the same reason only twenty cases of myalgia of my own observation can be presented here. Duration of the symptoms amounted from one week to two years, the age ranged from twenty-eight to sixty-seven years. Previous treatment was given without success in eight cases, and consisted of baking and massage and diathermia. The muscles of the shoulder were affected in fifteen, of the arm in two, of the forearm, neck and calf in one case each. Cure or improvement was achieved in eighteen (90 per cent), two cases remained unrelieved. No other treatment was given during the histamine therapy. The results are in good agreement with those published by the other authors which reported success in 90 to 95 per cent.

A thorough examination of all muscles of the affected part for pain, tenderness, contraction and nodules is of the utmost importance for success of the treatment. It is a common occurrence, for instance, that myositis of the trapezius muscle is diagnosed, while further examination would have detected tenderness and spasm of the deltoid and the pectoralis insertions as well. All affected muscles and the antagonists must be treated.

The effect of the treatment is very striking. Immediately after the very first application, pain and tenderness disappear and motion is increased. In case this initial effect is not pronounced, the final outcome must be viewed with scepticism. This analgesic effect remains first for several hours, corresponding to the changes in the circulation described above. The treatment is therefore repeated at first daily if possible, with the progress of the recovery, the painless intervals increase up to twenty-four to forty-eight hours. Treatment is now continued every second to third day, until all symptoms have disappeared. The number of treatments required varies from three up to twenty. In severe and chronic cases one is justified to continue as long as there is good immediate response to the treatment. As illustration four abstracts of histories are given.

THE THERAPY OF CHRONIC RHEUMATIC ARTHRITIS

CASE I—L O, fifty years of age, white, housewife Since three months, pain and tenderness over the right shoulder, limitation of abduction and elevation of the right arm Diathermia and massage did not bring relief *Examination*—Tenderness over the trapezius and insertion of the deltoid muscles, which disappeared immediately after the first treatment She returned with the statement that she was able to spend the night free of pain for the first time since the onset of the condition Pain relieved permanently after the first treatments, but tenderness did not subside completely before the seventh application of histamine

This case shows a prompt success of histamine after failure of diathermia and massage

CASE II—F O, forty-four years of age, white, housewife Four years previous, treated for calcified subacromial bursa of the right shoulder Since one week, pain, tenderness and limitation of motion of the left shoulder Menopause with thirty-five years, dermographism and acroparesthesia of the fingers *Examination*—Left trapezius and deltoid and pectoralis are contracted and very tender to touch Motion is restricted in all directions by the muscle spasm, maximum of abduction 40° After the first treatment tenderness disappeared, motion increased, abduction 120° Recovery complete after four treatments

This is an illustration of prompt recovery of an acute attack in an individual predisposed to rheumatic affections and circulatory disturbances

CASE III—C R, forty years of age, physician, white Since four weeks, pain in left shoulder, increased on motion of the arm While driving he is in the habit of leaning the bend of his arm out on the window and assumes that this exposure to weather and pressure have brought on this condition At the first examination, a hard and tender node the size of a hazel-nut was found at the insertion of the deltoid muscle The first treatment was given over this area alone Immediate disappearance of pain and tenderness lasting for several hours The nodule in the deltoid was not more palpable when he returned two days later, but there was still pain on motion of the left arm The reexamination revealed tenderness and contracture of the cervical portion of the trapezius and the insertion of the pectoralis muscles The symptoms disappeared after three treatments This case shows the importance of a thorough examination and treatment of all the affected muscles

CASE IV—A K, forty-five years of age, white, sign painter Since eight days pain in the right elbow increased on motion No evidence of lead poisoning *Examination*—The elbow-joint is normal, but tenderness present over the head of the flexor carpi communis There was only slight decrease of pain and tenderness after the treatment, and no permanent relief after three applications

The reason of the failure in this case could not be ascertained, as the patient discontinued the treatment

Muscle Affections Following Trauma, Static Strain or Disease of Bone and Joints—Successful treatment of pain and muscle spasm following trauma was reported by Deutsch in six cases, Thrumpp published eighteen cases with recovery in seventeen This result, if confirmed in a large series, would indicate a great progress in the after-treatment of injuries to extremities

In static myalgia chiefly due to weak feet, Vas reported good results in twenty-five out of twenty-eight cases In contractures of muscles, due to bone and joint affections, Kopits had improvement in twenty-nine cases, however, in sixteen cases, the results were only transitory Although the treatment in this group is only symptomatic, it could be made use of to correct faulty position in preparation of final measures

In three cases of calcified subacromial bursae, verified by roentgenograms, I have seen disappearance of pain, tenderness and return of complete motion after three to six treatments

Arthritis—Ninety-four cases of different types of arthritic conditions are listed. In eighty-five cases, improvement was noted, which, however, was only transient in twenty-one cases. The results are inconclusive on account of the small number of cases and the indefinite nomenclature used. (Deutsch and Kopits refer to their cases as arthritis deformans and polyarthritis, Vas writes of "joint diseases") I have under treatment a group of cases of osteo-arthritis and of rheumatoid (atrophic) arthritis. In some cases of the former, I have noticed a decrease in hypersensitivity and stiffness. In the second group some improvement in motion and decrease of pain occurred after treatment. However, prolonged observation in a large number of cases is necessary for definite conclusion in this eminently chronic group of affections. The results are expected to be of great importance, independent of the therapeutical effect. It will be possible to determine the actual influence of the peripheral circulation in different types of arthritis. The deep alteration of the skin circulation by histamine, if by itself without permanent value, could eventually be used as an adjuvant of a more specific therapy.

Neuralgia—Out of thirty-two cases of neuralgia, twenty-three were reported improved. Of these, nine only transitory improved. Deutsch had failures in three cases of neuralgia of the nervus cutaneus femoris lateralis and regarded histamine as ineffective in pure neuralgia and improvement as indication that the muscle was chiefly involved, especially in ischialgia.

Acroparesthesia—Vas reported good results in eighteen cases out of twenty of acroparesthesia of the hands or feet. I have a series of cases under treatment in women of middle age, complaining of numbness, hypersensitivity and paresthesias. To date, I have not seen any marked influence yet, but in these long-standing disturbances the treatment should be continued for a considerable length of time.

Miscellaneous Conditions—Deutsch had complete failure as to permanent results in ten cases of painful periostitis. Vas claims success in ten cases in furunculosis and in three cases of painful infiltrations after perivascular injections. Of considerable greater interest are his good results in a case of Raynaud's and in two cases of Buerger's disease and in three cases of chronic ulcer of the leg. The action of histamine in these conditions of disturbed peripheral circulation requires extensive investigation.

SUMMARY AND CONCLUSIONS

The application of histamine either by cataphoresis or by the scratch method is presented.

Alteration of the peripheral circulation is the principle underlying the treatment of rheumatic conditions and disturbances of the vasomotor system, by the application of histamine to the affected parts.

The effect of this treatment consists in a dilatation of the minute vessels

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and smaller arterioles, in an increase of the blood flow and permeability of the vessels which causes a hyperæmia and elevation of the skin temperature of several hours duration. Some evidence is given of a longer duration of the capillary dilatation after considerable treatment (Bettmann)

The results in 554 cases collected from the literature are surveyed. A definite conclusion of the value of this method is at present possible only in myalgia (myositis). Out of 361 cases 301 were either cured or improved, recurrences were noted in twenty-six cases.

Twenty cases of myalgia of my own observation are analyzed. Of these eighteen were cured or improved two remained unchanged. Immediate relief of pain and tenderness after the first treatment is of favorable prognostic significance in this group.

Thorough examination and treatment of all affected muscles and their antagonists are decisive for the success of the treatment.

The material is insufficient in the other conditions to draw definite conclusion.

Secondary myalgia after trauma, strain and due to static unbalance was benefited in a moderate number of cases.

Three cases of calcified subacromial bursa were successfully treated by me. A prolonged study in a large series of different types of arthritis is being undertaken first to determine the rôle of the alteration of the peripheral circulation, and secondly to study the eventual therapeutic effect of the histamine by itself or in conjunction with other therapy.

Finally the effect of the histamine treatment on disturbances of the peripheral circulation (Raynaud, Buerger and arteriosclerotic conditions and acroparesthesia) is under investigation.

NOTE.—I am indebted to Dr Jerome Weiss, director of the Physiotherapy Department at the Hospital for Joint Diseases for the arrangement of the cataphoresis apparatus, and to Miss Acton for carrying out of the treatments. The patients were derived partly from private practice and partly from the service of Dr Harry Finkelstein, Hospital for Joint Diseases.

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INDIRECT INGUINAL HERNIA IN THE LIGHT OF THE NEWER INTERPRETATION OF ANATOMY *

BY MAXWELL CHERNER, M D

OF PHILADELPHIA, PA

DOCTOR DRAPER, in his Foreword to Doctor Naccarrati's translation of Pende's Constitutional Inadequacies, states

"There is a peculiar quality of the human mind reminiscent of the rim of a wheel moving slowly onward through deep sand which covers the segment of its circumference For if one reviews the history of thought in any field of endeavor, the truth of that old saying, 'History repeats itself,' is quite apparent Yet beyond this, one may perceive

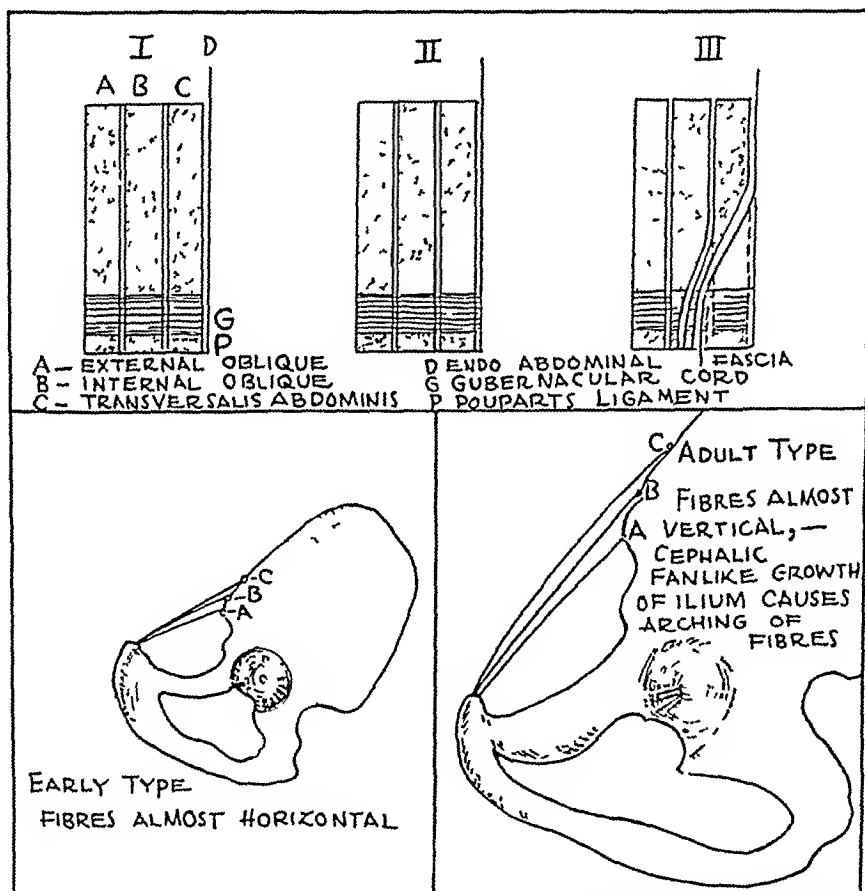


FIG 1—Schematic drawing (top) showing embryological development and cephalic recession of muscles of the interior abdominal wall, the fascial coverings maintaining their attachment to Poupart's ligament. The relative positions of the abdominal muscles in the early and adult stages of development are shown at the bottom.

the striking fact that simple repetition does not fully explain the remarkable growth of man's understanding. As the rising curve of the wheel emerges from the sand and swings upward and forward in the sunshine, the apparent dusty particles of the roadbed are illuminated and cast new light upon the path ahead. Such is the reciprocally energizing effect of ever leaping modern thought and the reposeful quiescence of ancient beliefs."

* Read before the Philadelphia Academy of Surgery, October 2, 1933

The above excerpt is used as an introduction, because it so aptly expresses the sustained interest in the subject, hernia, especially indirect inguinal hernia

Hernia is variously described and defined as the protrusion of a viscus, through defects or openings in the structures that ordinarily enclose or confine it. I have no fault to find with this generalized definition, but feel that in reference to the inguinal region the proper perspective has been slighted. It is my belief that the so-called openings, or rather the structures forming



FIG. 2—The average pattern with the transversalis abdominis arising from the lateral part of Poupart's ligament and the lower border of this muscle closely approximated to the spermatic cord and Poupart's ligament

the openings, through which the viscus appears, are the primary cause of the hernia, and not the viscus *per se*. Furthermore, these openings cannot be considered as defects or faults in the body, but rather as definite well-planned exits for structures which, through evolutionary changes, Nature has found to be most advantageously maintained outside of the abdominal cavity.

In the development of the average anatomical pattern of the lower ventral abdominal wall, the two primary factors to be considered are

- (1) The development of the undifferentiated abdominal wall-plate
- (2) The development of the gubernacular cord within this abdominal wall-plate

INDIRECT INGUINAL HERNIA

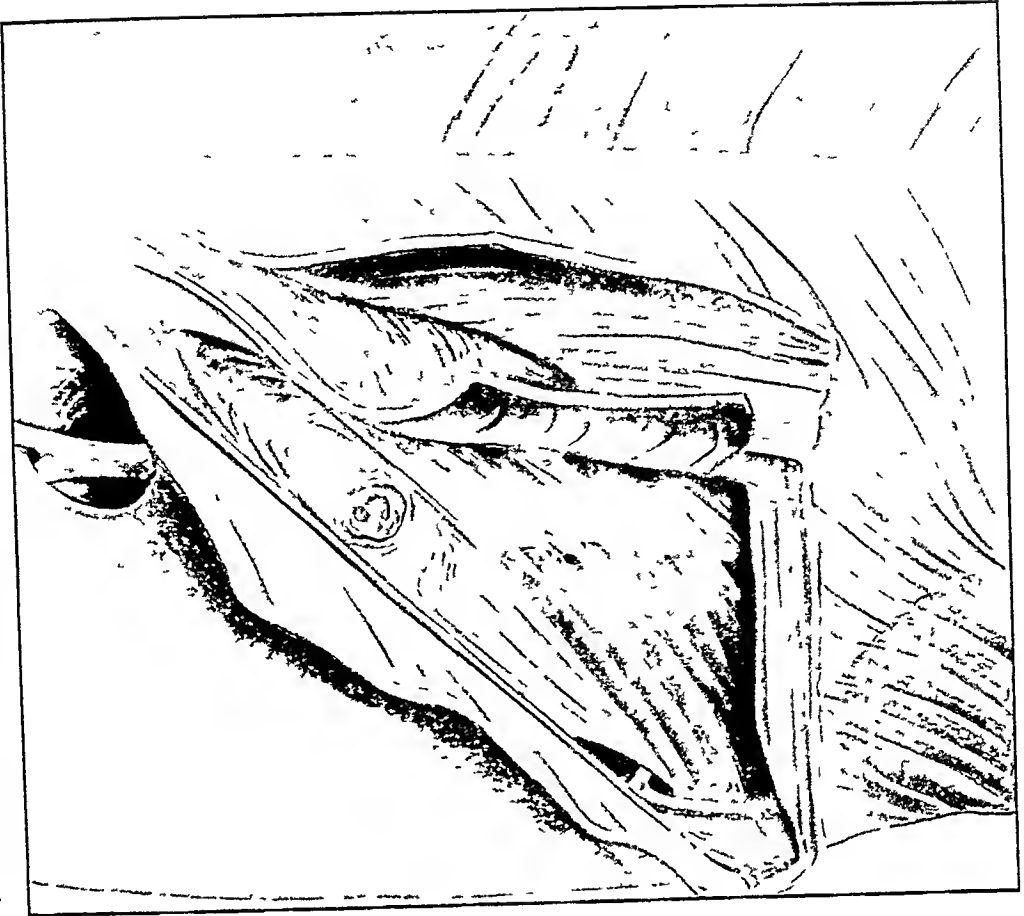


Fig. 3.—Variation in which the transversalis abdominis pulls Poupart's ligament, the lower edge of the muscle forming in it, but not hugging the spermatic cord.

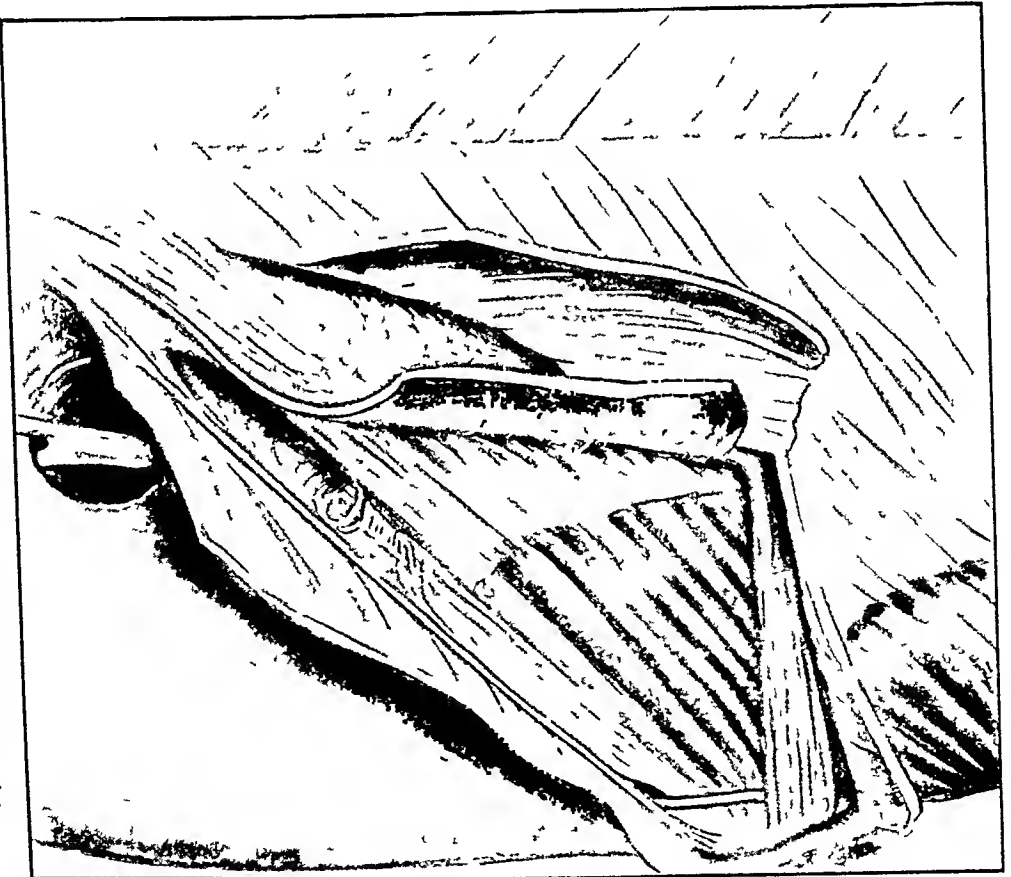


Fig. 1.—Variation showing the lower edge of the transversalis abdominis pulling Poupart's ligament, no neck of fibres being present.

1 *The Development of the Abdominal Wall*—The abdominal wall begins as an undifferentiated mesenchymal mass, the anterior abdominal plate, which is lined within by endo-abdominal fascia and peritoneum and without by external body fascia and skin. This undifferentiated muscle plate splits into three parallel, superimposed muscles which extend caudad to the line of Poupart, *i e*, from the iliac antero-superior spine to the pubic tubercle. Laterally and above, the plate is attached to the ilium and medially to the pubic bone. In the longitudinal growth of the body the muscle fibres of the internal two muscles, that is, of the transversalis and internal oblique, are pulled cephalad from the Poupart line in a fan-like movement, this process being accomplished by their own growth and by the growth of the ilium. As a result of this cephalic movement, only the fascial coverings of the internal oblique and the transversalis muscles remain. This results in an area of muscular deficiency, the size of which depends upon the amount of recession of the muscle fibres. Thus is formed what is considered by some a defect, but in reality is a point of exit for the testicle.

2 *The Development of the Gubernacular Cord*—Within the lower or caudal part of the abdominal mesenchymal plate and at right angles to its plane, a special structure is developed which is known as the gubernacular cord. This structure joins the inguinal crest and the testicular ligament on the inside and the scrotal ligament on the outside to become a completed structure—the gubernaculum testis, which then extends from the lower end of the testicular ligament to the skin of the scrotum. In the differentiation of the abdominal plate, the two inner muscles, transversalis and internal oblique, seem to enfold the gubernacular cord while the third or outer external oblique becomes evaginated for its exit. Because the gubernacular cord has no cephalic growth, the testicle is apparently pulled down, in reality guided through the then attenuated fascias and muscle fibres of the transversalis and internal oblique muscles, retaining them as coverings, these coverings collectively being called cremaster body.

When development is completed, the funiculus spermaticus—spermatic cord and appendages—acts as a substitute for the above outline pressure-resisting muscles, in the triangular space bounded by the pubic bone, the ilium, and the Poupart line. To protect this triangular space Nature then employs her contraction mechanism which closes it effectively, provided all essential structures involved adhere to the primary pattern and no variants develop.

Conceiving Nature as continually experimenting (or, as some call the process, evolving), one naturally comes to the thought that this evolving process causes changes, that is, variations in the primary pattern. These changes or variations, however slight they may be, will influence the definitive pattern, and, as applying to exits, will govern their size, shape, and tension.

In a comparison of the inguinal canal with the many diverse valvular constructions found in the body, one is impressed with the singleness of pattern or uniform mechanism employed, a fact which has heretofore not been sufficiently taken cognizance of in the literature. The mechanism to which I refer is the oblique projection of the structure to be valved or constricted through two or more layers of muscle, the valve effect or constriction being obtained from the muscle tone or by muscle contraction.

If the oblique projection of structures through two or more muscle planes be the universal scheme of valve construction, one would suppose that Nature would not radically change her method at a site as in the inguinal region where such a valve effect is necessary.

The insertion of the gubernacular cord, *i e*, the funiculus growth factor

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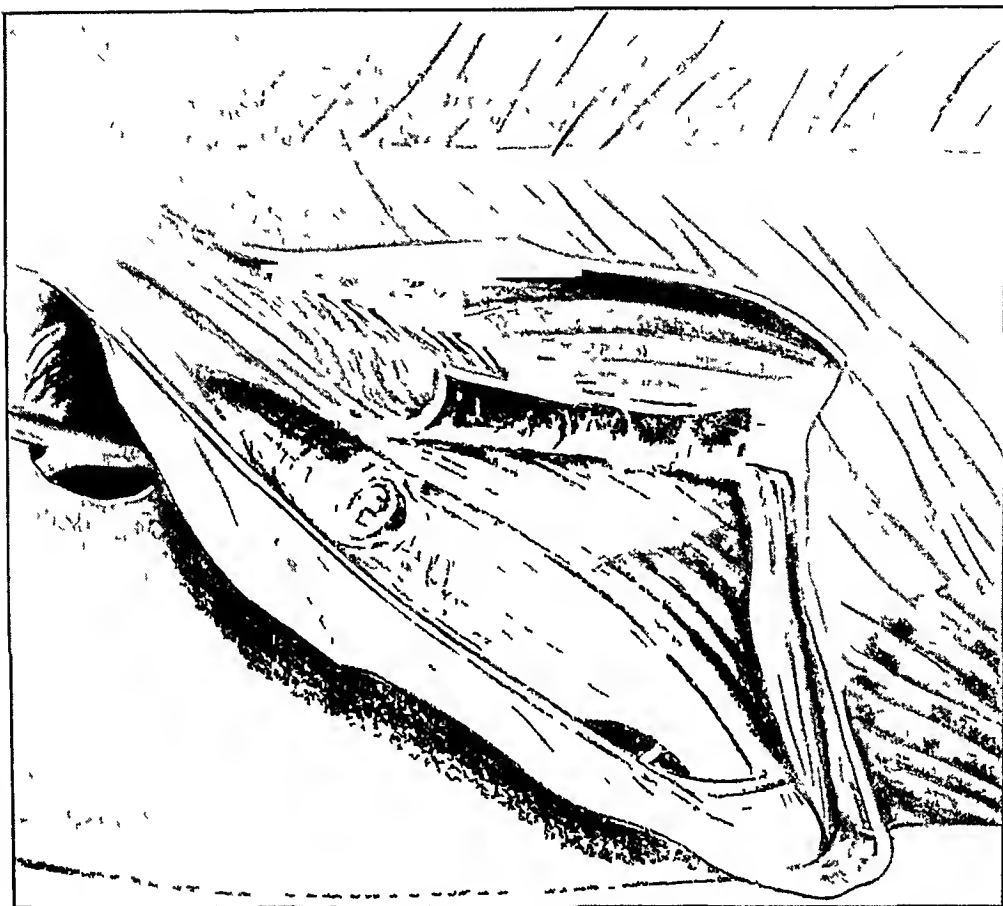


Fig. 5.—Type of variation in which the arching fibres of the transversalis abdominis reach the middle of the anterior superior spine, the maximum arching being found lateral and cephalic to the cord. In this type of variation even the maximum contraction of the muscle would not cause a closure of the triangular space bounded by the anterior superior spine, pubis and Poupert's ligament.

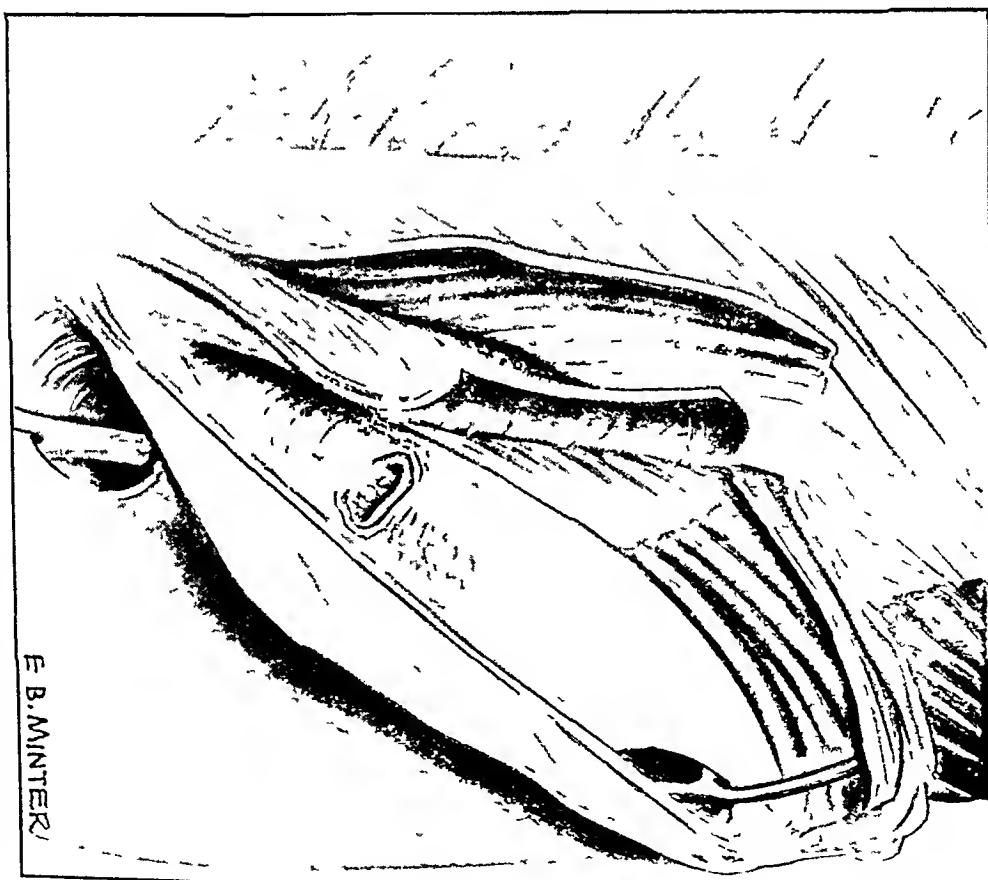


Fig. 6.—Variation in which the lower fibres of the transversalis arch above the anterior superior spine. The space lateral to the cord is very large making closure of the space between pubis, Poupert's ligament and the anterior superior spine impossible, even by maximum contraction of the transversalis abdominis.

E. B. MINTER

in the undifferentiated abdominal wall and the subsequent development about it of three parallel muscles, two active and one passive, gives evidence of such a valvular construction. These three muscles by their fan-like insertion, slide action, and contraction, normally close the triangular space bounded by the ilium, pubis, and Poupart line. This valvular construction Connell has called "the keystone of the inguinal arch," and MacGregor, after proving its sphincteric or valvular action, has named it "the inguinal sphincteric ring." MacGregor, Connell, and various other investigators, including myself, attach little importance to the pressure-resisting action of the external oblique muscle, for the reason that the external oblique muscle is never able to substitute as a valve component when the valve action of the transversalis and internal oblique muscle is deficient. Because of its fixation and early canalization, the external oblique muscle plays only a passive rôle in the resistance to intra-abdominal pressure.

While Nature seems to adhere to a single pattern of valvular construction, variations often develop, amid these are widened, narrowed, and attenuated conditions of the transversalis and internal oblique muscles, the depicted variations being due to either excessive pull or recession from the Poupart line. Such modifications produce a greater than ordinary triangular space between the ilium, pubis, and Poupart line and leave the space unprotected to a greater or lesser degree from the intra-abdominal pressure. As a result, the possibility for herniation is considerably enhanced.

Adequate knowledge as regards the potentiality for hernia is of primary importance to medical examiners of industrial employees. All of us have seen individuals with widely dilated external rings who, having been rejected because of believed potential hernia, have disappointed expectations and prophecies by not developing hernia, even after years of heavy lifting. On the other hand, it is well known that individuals with tight external rings who have been approved for employment returned very soon, in fact all too soon, to the medical examiner with well-developed hernias and in doing so caused him great surprise and chagrin.

Much has been said about methods, repairs, and hernial openings and the resultant successes and failures. Why the identical operation in a series of patients gives surgeons a variety of results, that is, no recurrence in a certain percentage, all grades of recurrence and complete failure in still another, still remains a major problem for analysis. Some authors attribute these diverse results to many factors, but few seem to have considered (in the few analyses available on the basic causes of these successes and failures) the individual who needs repair and why he needs repair. Upon the presentation of the individual for repair the thoughts of the surgeons are, as a rule, in terms of inguinal operations as outlined by Bassini, Ferguson, Macey, and Champonier, rather than upon the actual cause of the hernia, that is, failure of support due to evolutionary variations of the muscle components or to general muscle failure.

In view of what I have said on the development of muscles about the

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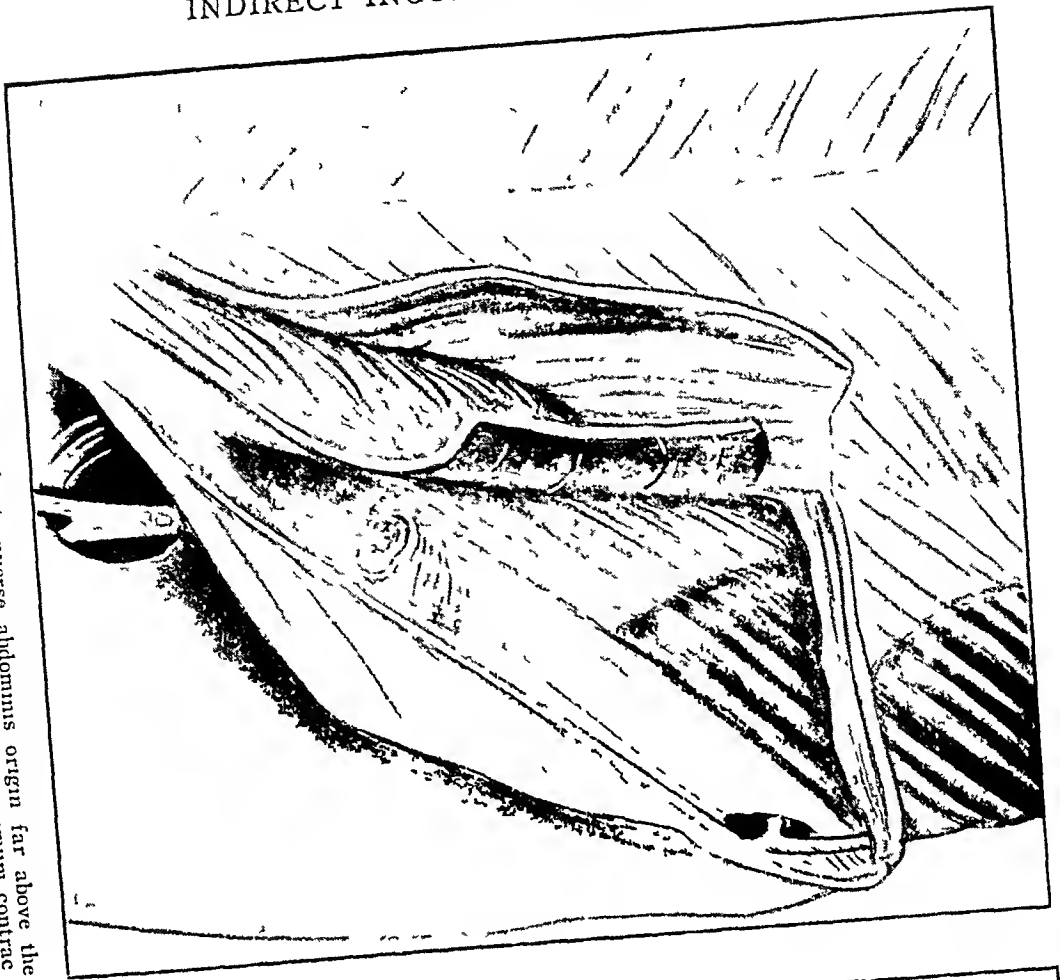


Fig. 7—Variation showing the transversus abdominis origin far above the anterior superior spine, closure of the triangular space by a maximum contraction being impossible

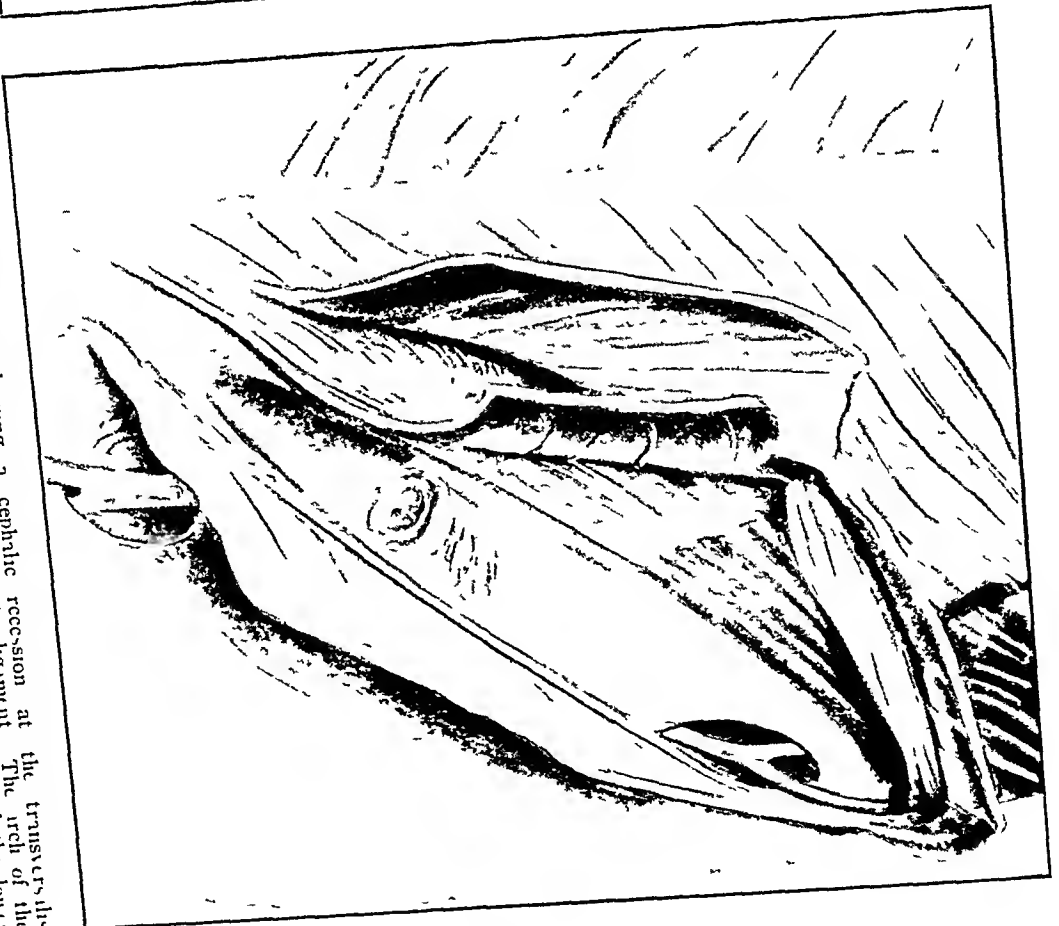


Fig. 8—Variation showing a cephalic recession at the transversus, the abdomen one and one-half inches from Poupart's ligament. The arch of the fibres of the muscle extends into the flank. An approximation of the lower edge of the fibres to the free margin of Poupart's ligament and the cord is not possible

inguinal canal, our old conception of hernia formation and potentiality should be revised, the newer interpretation comprises the following points

(1) The universal valve pattern and variations of that pattern as a cause of hernia

(2) The external ring has no influence in the prevention of viscus exit, and, therefore, should not be given the position of primary importance it now occupies in the examination of employees

(3) The internal arch formation of the transversalis and internal oblique muscles should be the primary consideration in all examinations since it is the active preventive of viscus exit

(4) Attention should be focused on the variational rather than upon the average anatomy as a basis for technic

(5) The surgeon should devise a technic to remedy the structural failure of the individual case rather than adhere to a surgical routine

The problem I have presented is an anatomical one. The important problem now is to determine whether inguinal hernia, direct or indirect, occurs more frequently in cases in which the space between the ilium, the pubis, and the inguinal ligament is largely unprotected. This has not been done. I am hoping to continue the study with this in mind.

I wish to extend thanks to Dr J. Parsons Schaeffer, Director of the Daniel Baugh Institute of Anatomy of the Jefferson Medical College, for his interest in this study and for the access to the anatomical material, and also to Dr N. A. Michels for his helpful suggestions in the preparation of this paper.

CYSTS AND SINUSES OF THE SACROCOCCYGEAL REGION*

BY THOMAS HERBERT THOMASON M D

OF FORT WORTH, TEX

FROM THE BEALL CLINIC

THE sacroccocygeal region, owing to its very complex embryology is perhaps the most common site in the body for anomalous cysts sinuses, and tumors of "developmental origin" "The caudal end of the embryo" says Moersch⁸ 'represents a Sargasso sea, producing as a result of its variegated structures a 'histological pot pourri' "It is in this area, according to Hundling,⁵ "that the caudal termination of the primitive streak should most accurately attain its involution and evolution, the neurenteric canal develop and disappear the anus complete the intestinal tube, and the inferior extremities symmetrically adapt themselves to the trunk' And in the same neighborhood the complicated processes of the genito-urinary tract arise

Tumors resulting from errors in these involved processes are, for the most part, cystic, though rarely a solid tumor is found They may be present at birth or make their appearance at any time subsequent to it Sooner or later sinus formation takes place, usually with infection

These cysts and sinuses may be divided according to their location into two classes those which lie dorsal to the sacrum and coccyx and those which lie anterior or ventral to these structures The former are quite common and are not infrequently seen in an ordinary practice Usually they have been operated on at least once They are commonly known as pilonidal (hair nest) sinuses or coccygeal fistulæ, occur most often in males, and are apparently peculiar to the white race Their pathology is relatively simple and their removal may be accomplished without difficulty if done carefully Stone,¹² in 1924, reviewed this subject and reported forty cases from the Johns Hopkins Hospital and his private practice An early reference of particular interest is a report of five cases of coccygeal dermoid by E J Beall,¹ in 1889

A much more formidable problem is presented by those cysts and tumors which lie in front of the sacrum and coccyx They present a more complex and varied pathology They produce more serious symptoms, and their surgical removal may be a very complicated procedure Pearse¹⁰ observes "the confusion of the amateur pathologist who attempts their study is only exceeded by the confusion of the amateur operator who attempts their removal' He reports a case of ventral tumor of the sacrum on which he operated three times before finally curing his patient They have been called Mitteldorpf tumors the term including a diversity of growths dermoid cysts, teratomata, carcinomata chordomata, and ependymal cell gliomata

* Read before the Texas Surgical Society, February, 1932

Law⁷ has given the name ventral tumors of the sacrum. He reported in 1922 two cases mentioning a total in the literature of thirty cases. Hundling,⁶ in a thorough review of the subject in 1924, reports nineteen cases from The Mayo Clinic.

From the above, it would appear that the incidence of this condition is relatively rare. Calbet collected 203 cases of sacral tumors in the newborn, finding them to occur once in every 34,582 births. The rare incidence in adults has been attributed to the fact that most infants so affected fail to survive the first year of life.

A discussion of these lesions would not be complete without a brief review of the embryology of the region in which they occur. To quote Hundling again, "During embryonic life while the entoderm is forming the caudal intestine, the dorsal canal and dorsal cord, the mesoderm, the connective tissue, blood-vessels, vertebrae, and muscles, and the ectoderm is forming the primitive streak, the medullary tube and its vestiges, there is a continuation between the central canal of the spinal cord and the primitive alimentary canal around the caudal extremity of the notochord. This canal, which forms the communication between the cord and the gut, is known as the neurenteric canal. When the proctodaeum or primitive anus invaginates to form part of the cloacal chamber it meets the gut some distance anterior to and above the point where the neurenteric canal opens into it, hence, there is for a time a segment of intestine behind the anus termed the postanal gut. This, as well as the neurenteric canal, later becomes obliterated."

While there are numerous and diverse theories as to the origin of sacrococcygeal tumors, it is generally agreed that most of the type considered in this article arise from vestiges of the neurenteric canal and post-anal gut, including the so-called coccygeal vestiges. The relation of the simpler dermoid cysts and sinuses lying behind the coccyx to the neurenteric canal is rather easy to follow. They contain hair and sebaceous material, are lined with epithelium, and may be traced as a rule to the hiatus of the sacrum. Stone¹¹ suggests that the same anlage which give rise to the "preen gland" of certain birds and to analogous structures of some mammals and reptiles may be present in certain individuals of the human species, developing for some reason into the structure known clinically as pilonidal sinus.

The more complex ventral tumors of the sacrum probably arise in many instances from the post-anal gut, and this theory is held by such observers as Keen, Bland-Sutton,² and Mitteldorpf, who was the first to describe these growths. Mitteldorpf tumors, however, include such a varied and bizarre collection that the question of their origin has not been definitely settled. Many of them, no doubt, arise from "totipotent" cells which have been set aside at an early stage in embryonic life to resume development years later. Others, like teratomata elsewhere, are really "parasitic fetuses" or suppressed twins.

The pathology of pilonidal sinus is simple. From a small orifice—post-anal dimple—it extends backward away from the anus toward the sacral hiatus as an indurated infected tract. It may extend laterally under the skin of the buttock for several inches. The symptoms are those of recurrent abscess formation, usually following an initial trauma, and present little

difficulty in diagnosis Pilonidal sinus must not be confused, however, with anal fistula, osteomyelitis of the sacrum and coccyx or simple pyogenic abscess

Ventral tumors of the sacrum tend to grow upward into the hollow of the sacrum eroding the bone, and displacing the pelvic organs anteriorly They are as a rule definitely encapsulated and may obtain considerable size Sinus formation with secondary infection forms a constant part of the picture and a history of multiple operations is common They are prone to undergo malignant degeneration, spreading by extension and invasion rather than by metastasis The symptoms are constipation, pains in the sacral region and down the thighs, swelling of one or both buttocks, and the presence of a persistent sinus The last may be the only indication of trouble Ventral tumors must be differentiated from the more common pelvic growths, as well as the rarer meningocele, myelocele, and spina bifida

The treatment of pilonidal sinus is careful excision of the sinus tract and cyst wall down to the point at which the rudimentary canal enters the sacral hiatus We have found the injection of blue dye, such as indigo carmine, very useful in delineating small tracts, though others, I am sure, get as good results with specially prepared paste Wide excision of the skin about the sinus has been commonly practiced, the wound thus made being expected to granulate and epithelialize after a period of many weeks A far better procedure, I find, is the excision of only a narrow tongue of skin including the sinus opening, the removal of no more tissue than is necessary, followed by primary closure of the wound, except for a small drain Cases so treated have in our experience healed promptly by first intent—a distinct improvement over the other method

Tumors of the ventral sacrum should be treated surgically, their removal being at best a formidable procedure Attempts at extirpation by the abdominal route uniformly failed on account of excessive hæmorrhage and inaccessibility of the lesion Law,⁷ in 1912, described a method of attack by the posterior route, using the Kiaske incision with removal of the coccyx and lower portion of the sacrum A wide opening can thus be effected and careful excision of all diseased tissue be carried out Thorough removal is essential, as the growths tend to recur In the case here reported it was necessary ultimately to modify this approach by incisions laterally into each buttock spreading the fibres of the gluteus maximus In most cases thorough radiation is recommended as an adjunct to surgery The prognosis depends on the nature of the tumor Recurrence is common and the incidence of malignant degeneration is high

This review of sacrococcygeal tumors was suggested by the following cases

CASE I—Mrs E. H., thirty-four, a seamstress, came to the Beall Clinic in August, 1929, complaining of pain and soreness in the sacrococcygeal region, a foul draining sinus posterior to the anus, swelling of the right buttock, fever, and constipation At six years of age following an attack of scarlet fever she developed an abscess posterior to the

anus which on incision was found to contain hair. Since then she has had many operations, with always a draining sinus. At eighteen, she had a laparotomy, the surgeon noting at the time a rough growth in the anterior sacral region. At twenty-five a surgeon attempted to remove the tumor, excising a very large mass of tissue containing hair. A year later the patient developed another abscess which was drained, following which she wore a tube four inches long until August, 1929, when her symptoms again became intolerable. The past history is not significant, except for the fact that the patient has had three miscarriages. The father and two siblings are living and well. There is a history



FIG 1—(Case I) Röntgenogram of pelvis showing sinus injected with lipiodol

of death from cancer in the paternal grandfather, both maternal grandparents, mother, two maternal uncles, and one maternal aunt—seven in two generations.

The patient was a well-developed, intelligent woman who was in much pain, looked sick and had a temperature of 101° . There was a draining sinus one inch posterior to the anus, in which the patient kept a rubber tube four inches long. The right buttock was greatly swollen and tender. On pelvic examination, the sinus tract with its tube could be traced to the left and seemed to run into a rounded mass in the hollow of the sacrum. To the right of this mass and connected with it was a hard and very tender mass which felt like chronic inflammatory tissue. Laboratory findings were negative. The sinus was injected with lipiodol and an X-ray made (Fig 1).

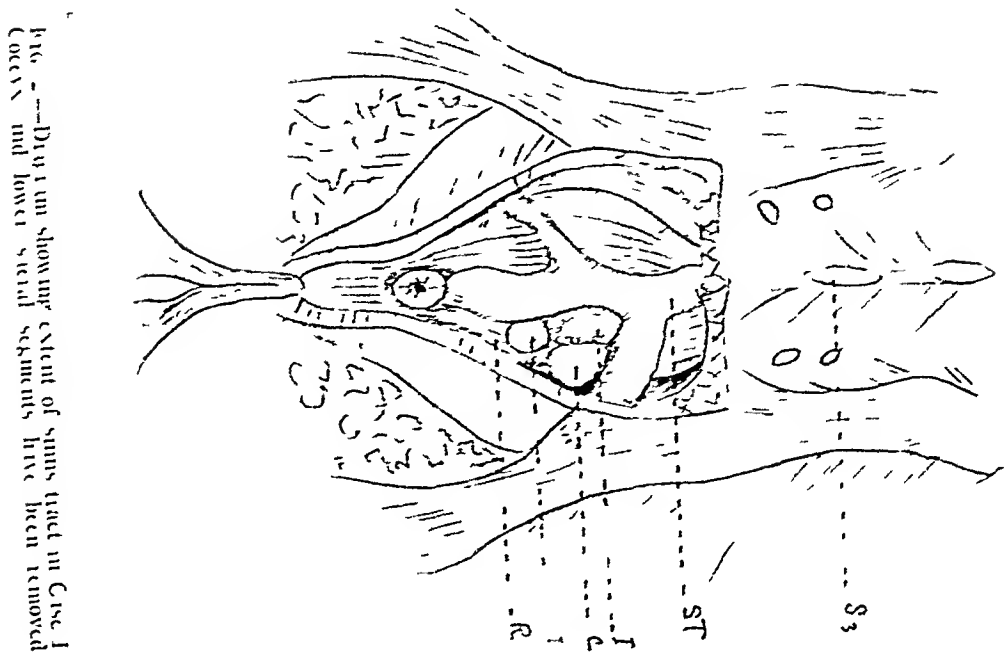


FIG. 2.—Diagram showing extent of sinus tract in Case 1. Coccyx and lower sacral segments have been removed.

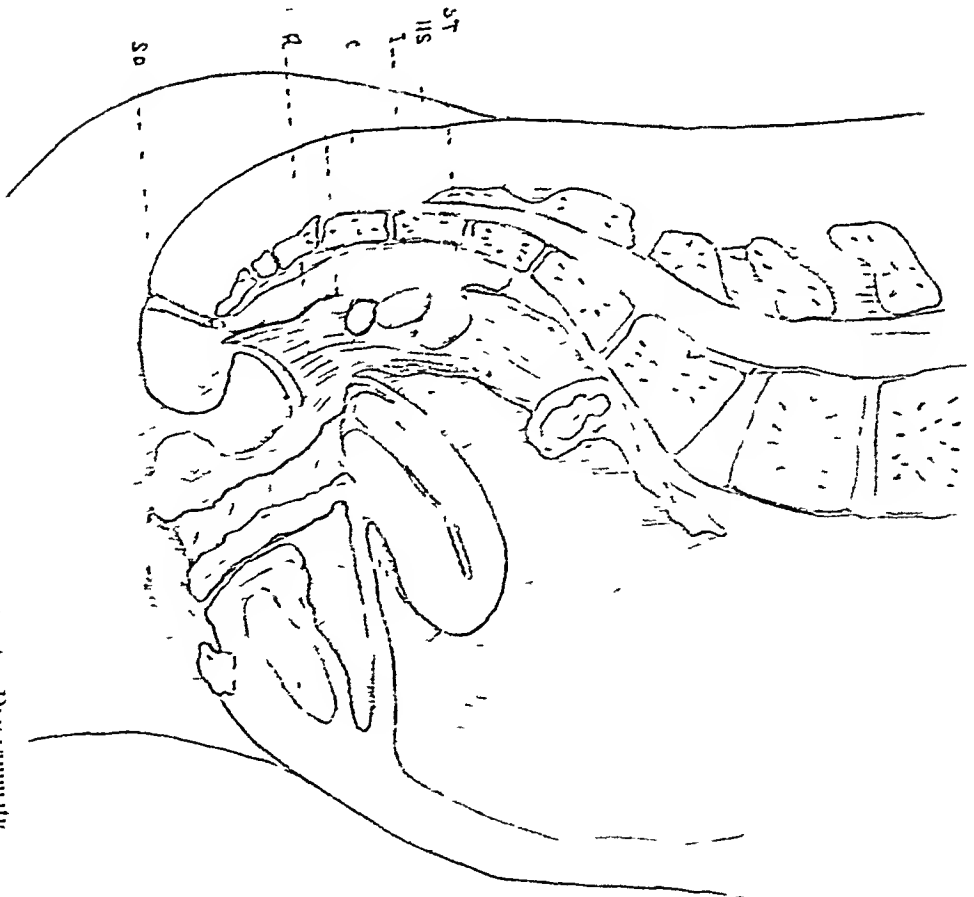


FIG. 3.—(Case 1) Internal view of sinus tract. Diagrammatic.

Operation—August 15, 1929, under general anesthesia, an attempt was made to dissect out the sinus tract. From its opening at the tip of the coccyx, it extended downward to the rectum, then upward and forward between the rectum and sacrum. At the base of the coccyx the y-tract divided, one branch extending to the left under the edge of the gluteus, while the other passed upward close to the sacrum and back downward to the right. The tract contained several ounces of foul soupy mucopus. The coccyx and lower three-fourths inch of the sacrum were removed. It seemed impractical to attempt complete dissection of the tracts, so they were thoroughly carbolyzed and the wound left open.

Symptoms persisted and November 26, 1929, a second attempt was made. The incision was widely opened and two cysts were dissected from the rectum. One was smooth-walled, containing thick mucoid material, and the other resembled grossly and microscopically a section of small intestine. Radium was left in the depths of the wound and the incision closed.

Symptoms still persisted and February 19, 1930, a last attempt was made to relieve the patient. The incision was laid open as before and in addition, incisions were made



FIG 4—Section through wall of sinus tract. Note structures resembling intestinal mucosa and Peyer's patch.

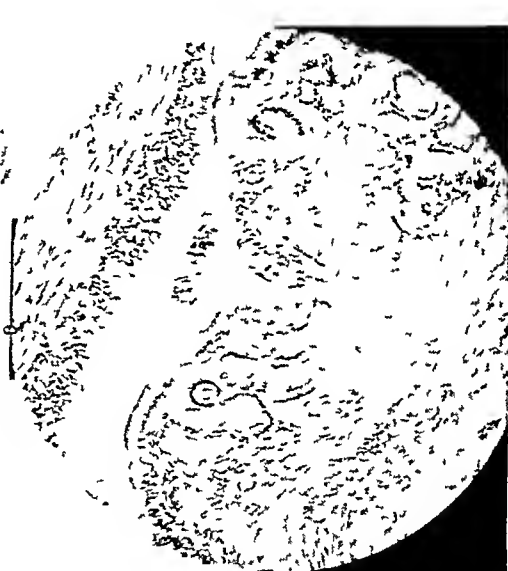


FIG 5—(Case I) Section through wall of sinus. Showing mucous glands.

laterally into each buttock from the upper third of the wound. The rectum was peeled clean posteriorly and the tract dissected out as indicated in the accompanying diagram (Figs 2 and 3). By means of the lateral incisions spreading the fibres of the glutei we were able to obtain much better exposure than on other occasions.

Following the operation the patient recovered rapidly and has had no more drainage. For the first time in twenty-eight years, she is free of a foul sinus which has clouded her entire existence. The lapse of two years finds her in perfect health.

CASE II—W R P, twenty-seven, had a draining sinus just to the right of the coccyx tip which began as a small swelling nine months before. It had been incised twice, once rather deeply, only to recur later. Examination showed a prominent elongated coccyx with a sinus tract opening 2 cm to the right of its tip and extending anteriorly. At operation this tract, injected with indigo-carmin, was followed inward to its terminus in a cyst-like structure which lay against the muscular wall of the

rectum about one and three-fourths inches from the opening of the sinus. The cyst was lined with a definite smooth membrane. Following its removal, the patient made an uneventful recovery.

CASE III—H. C. S., twenty-nine, noticed some soreness at the end of his spine after a fall on his back fourteen years ago. In recent years this has gotten worse and in the past few months he has been much inconvenienced by soreness and swelling which extended into the left buttock. Examination showed a definite post-anal dimple, from which an indurated tract extended subcutaneously for three inches into the left buttock. At operation the tract was dissected out, and though it had burrowed laterally for several inches it also extended upward posterior to the coccyx to the hiatus of the sacrum. The wound was closed, except for a small drain, and healed by first intent. The sinus tract contained hair and showed evidence of infection.

Comment—While growths of the Mitteldorpf group cover a wide range of weird malformations, tumors of the post-anal gut proper seem to have

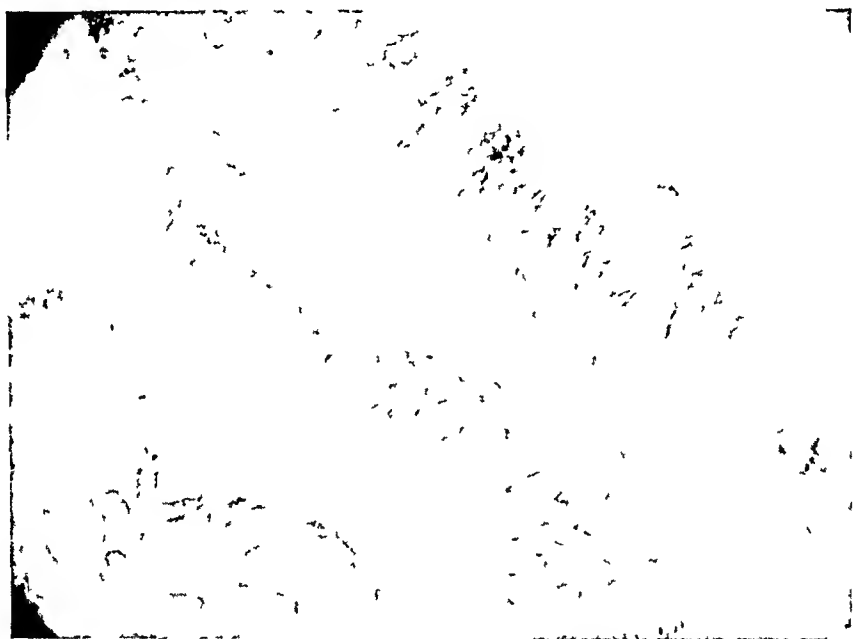


FIG. 6—(Case I) Section of sinus wall. Note mucosa suggesting villi of small intestine.

a rather constant pathological structure. "They are composed of closed vesicles lined with glandular epithelium, sometimes cuboidal and sometimes columnar in type. The cysts are filled with ropy, glue-like mucus and vary in size from four centimetres in diameter to the smallest space visible to the naked eye." The findings in Case I coincide closely with descriptions of typical tumors of the post-anal gut. As a matter of fact, the specimen removed was a post-anal gut. Careful examination reveals that the entire sinus tract, with the exception of the part destroyed by inflammatory change, was composed of intestine with typical longitudinal and circular muscle fibres and a mucosa which contained glands, apparently from various levels of the alimentary canal (Figs. 4, 5 and 6). Some of the sections show definite Peyer's patches. The characteristic closed vesicles described by Bland-Sutton² and others^{3, 4} were observed, containing the typical ropy, glue-like, mucous secretion. No hair was found in any of the tissues removed by us.

The history of its having been removed at previous operations suggests, of course, that our tumor, whatever else it may be, is a teratoma, perhaps, a "suppressed twin"

The cyst in Case II probably originated from the post-anal gut. There were associated anomalies such as the enlarged tail-like coccyx and a non-fusion of the lamina of the first sacral vertebra.

Case III represents a bizarre type of pilonidal sinus. We have operated on a number of these cases in recent years. In one the usual wide excision of skin and tissue was done. His convalescence included many weeks of daily dressings. In five a minimum amount of skin was excised, the tract was carefully dissected out instead of the usual removal *en bloc*, and the wound closed, except for a small drain. All got primary union and were well in less than three weeks. There has been no recurrence in the series. While the idea of tissue conservation and primary closure in these cases is hardly original with me, there is little reference to it in the literature. It is much to be preferred to the usual method of wide excision because it lessens post-operative discomfort, it decreases the period of convalescence, and, lastly, it is neater surgery.

Summary—Sinus openings in the sacrococcygeal region are usually the external manifestations of cysts or tumors of developmental origin. These cysts are classified with respect to their location behind or in front of the bone into pilonidal sinus and ventral tumors of the sacrum. Rudiments of the neurenteric canal and post-anal gut probably give rise to many of these growths. Sinus formation, infection, and multiple operations is the rule. The diagnosis is not difficult if a careful examination is made, including a digital exploration of the rectum. The treatment of both types is complete surgical removal.

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PERIANAL TUBERCULOSIS~

BY FRANK B BERRY, M D

OF NEW YORK CITY, N Y

FROM THE DEPARTMENT OF SURGERY, COLLEGE OF PHYSICIANS AND SURGEONS, NEW YORK CITY FIRST SURGICAL DIVISION, BELLEVUE HOSPITAL

It is really only within the past decade that the true relationship between fistula in ano and tuberculosis has been defined, and the problem is still somewhat obscure to many of those to whom it is of most concern—the phthisiologists and surgeons. On the one hand some still feel that most fistulæ are tuberculous and indicate the presence of the disease elsewhere, and others are of the opinion that the surgical treatment of fistula is contra-indicated for the patient with pulmonary tuberculosis. It is with the purpose of combating these misconceptions that I present eighteen proved cases of tuberculous fistula and perianal tuberculosis and combine them with the already recorded experiences of others. Twelve are my own, five were operated upon by Dr A V S Lambert, and one by Dr J A McCreery.

Pathology and Incidence —Perianal tuberculosis appears in several forms. The commonest are (1) the perirectal abscess, usually with secondary infection, (2) fistula in ano, and (3) a soft, indolent perianal ulcer. More rarely it may appear as (4) a lupus, (5) a subcutaneous or submucous nodular lesion, (6) an unusual hyperplastic type simulating neoplasm. Tuberculous ulceration of the rectum itself is rare. The tubercle bacillus in the intestinal contents gains entrance to the perianal tissues by the usual paths of infection in fistula and abscess formation through a diseased crypt, with fissures or local abrasions or irritations, with hæmorrhoids, or from foreign bodies. It is conceivable that it may arrive here also by the hæmatogenous route in a small number of cases, particularly if any of the above conditions are present. If an abscess is formed, it may appear as the typical ischiorectal variety with secondary infection, or it may remain for a time as a non-tender swelling with induration of the subcutaneous tissues near the mucous margin. Eventually this becomes secondarily infected or softens and breaks and then persists as an indolent swelling with profuse thin purulent or watery discharge, and the edges of the opening heaped up with pale unhealthy granulations. The same description holds true when one of these secondarily infected abscesses has been inadequately opened after the pyogenic infection has begun to subside.

When a fistula is present the external opening is large with purplish, overhanging edges and there is a copious, thin, creamy discharge. As in the non-tuberculous fistulæ there may be multiple external openings with extensive spread of the infection to the surrounding tissues of the ischiorectal fossæ and perineum and eventually even to the buttocks themselves. There is usually only one internal opening and this is generally superficial or between the sphincters. Occasionally, just as with the non-tuberculous fistulæ, there are

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two or more internal openings, this occurred but once in the eighteen cases here reported. A fistula may complicate or be complicated by a perirectal abscess, in the former instance it may be of the blind external variety due to inadequate drainage of the original abscess.

The third common form of perianal tuberculosis is the ulcerative type. Here a soft, shallow ulcer appears at the mucocutaneous junction. The ulcer is characteristically tuberculous with a sluggish gray base and overhanging bluish edges. It spreads slowly either up into the anal canal or out into the subcutaneous tissues of the perineum and ischiorectal fossæ. As a rule it appears at the site of some preexisting lesion such as a fissure or hæmorrhoids. Two examples of this are included in my series: the first followed an operation for hæmorrhoids in the presence of an active pulmonary lesion with positive sputum, the second complicated a small fissure and was the presenting symptom of an active, incipient tuberculosis of the lungs.

One example of the nodular type is reported here. This appeared during convalescence following excision of a fistula. Successive soft and only slightly painful nodules appeared in the perineum and subcutaneous tissue of the ischiorectal fossæ. If left to themselves the overlying skin became gradually discolored and thin and finally broke. Simple excision resulted in prompt healing.

Diagnosis and Incidence—Inasmuch as fistula and abscess comprise at least 85 to 90 per cent of these perianal lesions, the chief problems of comparative frequency and accurate diagnosis occur in those groups.

TABLE I
Fistula in Ano

	No. Cases	Per Cent Tuberculosis
Allingham	1632	14
Pennington	701	14
Fansler	204	2.5
Melchior	132	61
Mayer	139	9.5
Frey	72	6.9
Elting	105	8.6
Dudley	72	1.4
Gabriel	72	20
Stone	31	10
Personal	102	25.5
Bue	1000	5.4
Gaston and Hogan ⁶	108	12.9
Chisholm	106	12.9
Gant		10
Thoss		5.5
Hartmann	200	50
Berry (Presbyterian Hospital)	160	10.6
Berry (Bellevue Hospital)	202	18.3

Above table taken from Tung,¹⁵ with series by Bue, Gaston and Hogan, Chisholm, Hartmann and the author added.

Table I gives the number of cases of fistula reported by various authors within the past twelve years and the percentage recorded as tuberculous. This latter shows the astonishing discrepancy between a minimum of 1.4 per cent tuberculous fistulæ in a series reported by Dudley and a maximum of 61 per cent in Melchior's 132 cases. Three reasons for this variation are immediately suggested. First, there would naturally be a difference between a group of cases selected from a general hospital service and one from a tuberculosis sanatorium or a hospital with an attached tuberculosis service or affiliation. Secondly, many fistulæ are operated upon, either by incision or excision without any subsequent tissue or bacteriological examination. Furthermore, tuberculosis, even when present, is frequently missed in that too few sections are studied. Thirdly there is a variation in the methods used for diagnosis. Some authors insist that the diagnosis must be proved by the presence of tubercle bacilli in the discharge, histological evidence, or guinea-pig inoculation. Of these, the last is the most reliable although all are open to error, thus Gabriel's figure of 20 per cent is based on positive guinea-pig inoculations. Others are not as rigid but base their figures on the clinical appearance of the abscess or fistula even with negative histological findings. Tissue for microscopical examination should be carefully selected and even then there may be so much simple acute and chronic inflammatory reaction present that the underlying tuberculosis may be missed. Buie^{1, 2} states that of his thousand cases, although fifty-four were clinically tuberculous, yet this could be proved histologically only in twenty-two. Out of all this but one fact stands out clearly: fistula in ano is not usually tuberculous as was formerly thought, on the contrary tuberculosis is present only in a small percentage of fistulæ, probably not over 10 per cent.

There is, nevertheless, a causal relationship between fistula in ano and pulmonary tuberculosis. Of 9,840 admissions in one year to two large general hospitals, fistula was present in only 0.6 per cent.

TABLE II
Cases of Pulmonary Tuberculosis with Fistula in Ano

	Cases Pulm. Tbc	Per Cent Fistula
Leslie ⁹	3452	2.2
Walsham	891	8
Buie	9568	2.73
Buie (Trudeau)	4160	1 plus
Smith		1-30
Hartmann		4-5
Martin		7

Table II, on the other hand, states the percentage of fistulæ as found in patients in various tuberculosis sanatoria and hospitals and demonstrates a consistent and definitely increased incidence. Again opinions differ as to the percentage of tuberculous fistulæ in patients with phthisis. Fansler⁵ states that 15 per cent of these fistulæ are tuberculous, Leslie⁹ says that they are nearly all positive in patients with active phthisis, Smith¹⁴ gives 4 to 10 per

cent as tuberculous, and Clark says that 20 per cent can be proved by guinea-pig inoculation Chisholm^{3 4} reports a series of thirty-one active pulmonary cases operated upon of which twenty-four (77 per cent) were proved positive for tuberculosis, of eighteen inactive cases only ten (55 per cent) were positive In a recent article Martin¹¹ thinks that more than 72 per cent of fistulæ in patients with pulmonary tuberculosis are tuberculous Seven per cent of all pulmonary tuberculosis cases in the Municipal Tuberculosis Sanatorium in Chicago presented anal fistulæ As is expected, therefore, it is evident that the incidence of tuberculosis in fistula in ano in patients with active pulmonary lesions is definitely increased

There is, furthermore, general agreement that tuberculosis is rarely if ever primary in fistula, in more than 98 per cent of the cases the original focus is elsewhere It may, however, be the initial sign of the disease, which should always be suspected with the appearance of a fistula in an underweight individual

Treatment—The only proper treatment of perianal tuberculosis and fistulæ is complete excision whenever possible Secondly, infected ischio-rectal abscesses should be widely drained and then later the remaining tract excised should one persist 'The removal of this suppurative focus benefits the patient Toxæmia is reduced and the patient is made more comfortable' Fistulectomy carries out one of the cardinal tenets of present-day therapy *i e*, elimination of tuberculous or non-tuberculous complications to focus healing ability on the pulmonary lesion" (Martin¹¹) There is still a widespread feeling against surgery, however Within the last year the head of a well-known tuberculosis sanatorium advised against operation for fistula in ano in one of his patients on the ground that no cure could be accomplished, rather the condition might be aggravated Similarly it was the opinion of the surgeons of one of the services in a large general hospital that a tuberculous patient referred to them with multiple fistulous openings in both ischio-rectal fossæ should not be operated upon because tuberculous fistulæ do not heal Both of these patients were operated upon by me with resulting cures One developed several subcutaneous tuberculides in the course of his convalescence, all of which were successfully excised, the other was operated upon in two stages and healed promptly

Chisholm,⁴ in 1928, sent a questionnaire to a number of physicians in Colorado as to their opinion of operation for tuberculous fistula His questions and replies were

Do you recommend operation? Yes, 2 No 22 Selected cases, 4
 Apparent end-results? Unfavorable, 24 Favorable, 41
 Anæsthesia employed? General, 28 Local, 0
 Technic? Knife, 28 Cautery, 0

He uses the cautery as he thinks the knife opens up new channels for infection and spread and also the cautery prevents the growth of the tubercle bacilli He reported a series of twenty-two cases of complete or multiple tuberculous fistulæ all cured following cautery excision under sacral or caudal anæsthesia

PERIANAL TUBERCULOSIS

The usual objections to the surgical treatment of fistulæ are that (1) operation may cause general dissemination of the disease This is not so and hence is a needless fear

(2) Operation is said to diminish the resistance of the tuberculous patient Again this is not true On the contrary, patients are frequently greatly benefited In the case of E U, the temperature, which had been up to 100 to 101° daily, promptly subsided, the wounds healed after two further minor excisions, and now, seven months after his operation, he is working as an automobile salesman

(3) Another objection is that the fistula can not be cured by operation and is merely converted into an ulcer Again this is contrary to fact if the operation has been properly performed and the dressings carefully supervised This may occur at times due to too prompt closure of the skin with the persistence of a shallow undermining ulcer in the lower anal canal It has occurred twice in my series once the ulcer was reexcised and curetted with a good result The second case is now under treatment following a similar procedure Both were ward cases and I feel that both could have been avoided by more painstaking dressings

Hartmann,⁸ in controverting these objections, states that he has operated successfully upon 584 cases of tuberculous fistula in ano Martin reports seventy-five cases with 87 per cent cures

TABLE III
Author's Series

	Sex	Pulm Tbc	Rectal Lesion	Result
K L	Female	Arrested	Fistula	Cured
J E	Male	Quiescent	Fistula	Cured
J B	Female	Active	Ulcer	Cured
I C	Female	Arrested	Fistula	Cured
J K	Male	Active	Abscess	Cured
H S	Male	Active	Fistula	Cured
H P	Male	Arrested	Fistula	Cured
J F	Male	Arrested	Fistula	Cured
H R	Male	Arrested	Fistula	Cured
R E	Male	Arrested	Fistula, Nodular	Cured
E U	Male	Quiescent	Fistula	Cured
J H	Male	Arrested	Fistula	Cured
F I	Male	Active	Fistula	Cured
E H	Male	Active	Fistula	?
V N	Male	Active	Ulcer	Cured
W K	Male	Active	Abscess	Improved
A B	Male	Active	Fistula	Unimproved
W B	Male	Active	Fistula	Improved

For all operations in the perianal and perineal regions in tuberculous patients, whether active or quiescent I believe that a low spinal anæsthesia is the best form of anæsthetic It is safe easy to administer, gives perfect anæsthesia with complete relaxation of the sphincter, and yet offers the minimum of disturbance to the respiratory tract A 50 or 100 milligrams dose of novocaine (procaine) crystals is used, these are dissolved in 1 to 2 cubic centimetres of spinal fluid As the puncture is begun 50 milligrams of

ephedrine are given subcutaneously. If, for any reason, spinal anaesthesia is not possible I should prefer avertin or sodium amytal and ethylene, or else chloroform. With abscess I have practised wide incision and evacuation, wiping out the cavity with 95 per cent phenol, and packing with iodoform gauze for three or four days. Following this 95 per cent phenol is used to paint the walls of the cavity every five or six days and dry dressings applied. Further packing is required only if there is a tendency for the mouth of the wound to heal too soon and then it is inserted very loosely only occasionally. Absolute cleanliness is of course essential and sitz-baths are very helpful.

For the excision of ulcers or fistulae the patient should be thoroughly prepared beforehand. He is given a cathartic preferably two days before operation, and a cleansing enema on the intervening day and also on the day of operation two to four hours before going to the operating room. This provides a clean field and prepares the intestinal tract for a period of post-operative constipation. An ulcer is completely excised with the cautery, endothermic knife, or scalpel. So far I have used only the last-named. The wound is then treated with 95 per cent phenol and packed with iodoform gauze for three or four days until granulations form, then the further treatment is the same as that already outlined. If the ulceration is extensive, it may be wise to perform the operation in two stages.

In dealing with fistulae a careful study should be made of them and their various openings, both external and internal, and a plan of operation formulated. The fistulae should be *carefully* probed or a dye or bismuth paste injected. If there is more than one internal opening, the operation should be carried out as two or more separate procedures. This applies also if there is only one internal opening but several external with extensive involvement of soft parts. With the exception of the pararectal variety of fistula, which, fortunately, is extremely uncommon as a tuberculous lesion, the entire fistulous tracks and their ramifications in the perineum or buttocks must be excised. Inasmuch as most fistulae originate in diseased crypts, this can be easily done. The only exception is that if the disease involves the sphincter muscles to any extent some diseased tissue must perforce be left here. As the wound heals, it may be possible to remove this at a later date if necessary. When more than one operation is indicated, as for multiple lesions, each procedure should be thorough within the limits of the field of operation for that stage. Ninety-five per cent phenol may or may not be used, and the wound is left open and packed with iodoform gauze for three to five days. This insures healthy granulations and resistance to reinfection. Following the removal of the packing the patient is given daily sitz-baths and instructed in keeping the wound as clean and dry as possible. Further very light packing may be necessary occasionally. Ninety-five per cent phenol is used every five or six days and at these times the finger should be inserted into the rectum to break up false healing and assure proper granulation from the depths of the wound outward. The bowels are usually opened on the fifth to seventh day by an oil enema and mineral oil and milk of magnesia or licorice powder. Complete healing will vary from a few weeks to several months. I have had little ex-

perience with the use of the actinic or ultra-violet rays or natural sunlight during convalescence, though I believe they should prove most helpful

One of my cases resulted in incontinence of the sphincter. He had a far advanced active pulmonary lesion but was having so much pain and discharge that operation seemed indicated. His resulting incontinence was due to too great enthusiasm on my part in trying to correct a large horseshoe fistula with extensive involvement of the sphincters all at once. This result could have been avoided by planning two operations instead of one. Of the others, four are still under treatment and progressing favorably, and the rest are cured.

SUMMARY AND CONCLUSIONS

Various types of perianal tuberculous lesions have been described.

The proper treatment for these conditions, except the very rare already healed variety, is excision.

Fistula in ano is not as frequently tuberculous as has been commonly supposed. Most are due to simple pyogenic infection. Probably not over 5 to 10 per cent are tuberculous.

There is, however, a causal relationship between fistula and tuberculosis in that the incidence of fistulæ is higher in tuberculosis sanatoria than in general hospitals.

Not all fistulæ even in tuberculous patients are themselves tuberculous particularly if the pulmonary lesion is quiescent. In active pulmonary cases probably 75 per cent or more fistulæ are likewise tuberculous. In the arrested cases probably only 15 to 20 per cent of the fistulæ are tuberculous.

Tuberculosis is rarely, if ever, primary in a perianal lesion, the original focus should always be sought elsewhere in the body.

Eighteen cases of perianal tuberculosis are reported. All were treated surgically by excision with thirteen (72 per cent) resulting cures. Five of these patients had active pulmonary lesions. Four others are improved and still under treatment, one is almost entirely healed. There has been one complete failure in a patient with an associated advanced bilateral pulmonary lesion.

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INTERNAL HÆMORRHOIDS COMPARATIVE VALUE OF TREATMENT BY OPERATIVE AND BY INJECTION METHODS

A SURVEY OF 62,910 CASES

BY NORMAN J KILBOURNE, M D

OF LOS ANGELES, CALIF

WHAT IS the comparative value of operative methods and injection methods in the treatment of internal hæmorrhoids? This problem has far-reaching importance, both because it is raised frequently and because there is lack of agreement as to the answer. Routine health examinations show how frequently it is raised. The United States Public Health Service¹ found hæmorrhoids in 10 per cent of 10,000 supposedly healthy male workers. Forty-two life insurance companies found hæmorrhoids in 13 per cent of 100,000 applicants. If to those who have such trouble we add those who have had it and have recovered, the total would show one in every six adult Americans with a history of hæmorrhoids, and probably 20,000,000 persons in our population will be at one time or another concerned with the answer.

Lack of agreement as to the answer is common knowledge, but this lack of agreement is due to insufficient data and not to lack of experience. We have been using both methods long enough so that we ought to know what they can do. Operative methods are at least as old as Hippocrates, who (400 B C), practiced transfixion and ligation of the hæmorrhoids of the citizens of Athens.² In the days of Tiberius Cæsar, Celsus³ at Rome added excision to ligation, and his detailed description of technic still makes excellent reading in operative surgery. Later but still almost a thousand years ago, the Arab physician, Abulkasim (Albucasis)⁴ in Spain introduced cautery removal. Although medical diathermy was introduced for rectal treatment in France by Professor Doumer of Lille in 1897,⁵ Durand Boisleard of Paris is said to have first used surgical high frequency for hæmorrhoids in 1924.⁶

Less venerable, but old enough, are the injection methods. Injection of chemicals into hæmorrhoids for their cure was first practiced by Mr. Morgan, surgeon to Mercer's Hospital, Dublin, using iron persulphate in 1869.⁷ Phenol solutions were popularized by the itinerant irregular Mitchell in Illinois in 1871.⁸ Mitchell and his followers used 50 per cent phenol solutions with the deliberate purpose of making the hæmorrhoids slough out. Nowadays weak solutions of 5 per cent phenol in vegetable oil or glycerine are used with intent to avoid sloughing and to cure the hæmorrhoids by causing sclerosis of the venous sinuses by interstitial inflammatory reaction. In 1913, E. H. Terrell,⁹ of Richmond, Va., introduced 5 per cent quinine urea hydrochloride. In Berlin, in 1917, Boas¹⁰ began using alcohol. Seventy per cent alcohol is used by both Boas and Elsner in Berlin and by Bonheim in Hamburg. Delater and Vendel,¹¹ of Paris, in order to avoid small sloughs following the

use of quinine urea hydrochloride, have recently introduced quinine and urea chlorhydrolactate in 5 per cent glycerine, which is a less acid salt than quinine and urea hydrochloride and is less likely to cause sloughs

Arguments in Favor of Operation—Advocates of operation argue Operative methods are performed under aseptic conditions and allow a perfect control of the amount of tissue removed They allow the removal or drainage of other diseased conditions which commonly occur with the hæmorrhoids, notably infected crypts They allow the removal of venous dilatations under the skin border which later cause thrombotic piles Operations do not cause sloughs, oily tumors, and rectal stricture Operation is immediate and avoids many treatments lasting sometimes for weeks or months Operative results are permanent whereas favorable results from injection treatment are frequently followed by recurrence of the hæmorrhoids

Arguments in Favor of Injection—Advocates of injection treatment argue Injection solutions cannot introduce infection¹² because they are powerfully bactericidal solutions¹³—indeed, an anal canal with chronic infection shows prompt improvement after injections started well above the hæmorrhoids Injections avoid rectal stricture¹⁴ because they are made underneath the mucosa without stripping off, burning, or puckering up the mucosa When rectal strictures followed injection treatment they were due either to sloughs or to oily tumors Sloughs were due to the use of antiquated, strong caustic concentrations of phenol Oily tumors were due to the use of that abomination, the paraffin derivative, mineral oil¹⁵ Injection treatments avoid all the post-operative pain that follows many operative procedures Injection treatments avoid hospitalization They involve the patient in one-fourth of the expense of an operation They do not interfere with his regular occupation, and give him what he wants Recurrences are due to insufficient treatment, and when they do occur, it is a simple matter to give a few more injections

Method of Survey—Argument cannot go much farther in settling this problem It should be taken out of the field of barren controversy and into the field where it belongs, the field of clinical research A searching study of results from both operative and injection methods to determine the bare objective facts ought to free us from possible subservience to idols of the forum upraised by the partisans of both sides

There were two possible methods of study One would make an inquiry into all unfortunate results of hæmorrhoid treatment throughout the country Such a method would gain but little For example, if we should suppose, hypothetically, that in one city, five cases of hæmorrhage had been reported following operation or injection, we should have no idea whether the five cases by either method resulted from fifty cases so treated, or whether they resulted from 50 000 cases, as a legitimate risk It would be impossible to determine by such a method the original conditions necessitating treatment, the technic used, or how far the rules of the game had been played¹⁶

The second method of inquiry which I have chosen is to study the results

of both methods at their best, with a control and knowledge of the original clinical conditions. The facts which follow are the result of a questionnaire addressed to 293 proctologists in America, Great Britain, France and Germany. On the suggestion of Curtice Rosser, the American proctologists were taken from a list of members of the American Proctological Society together with men who, though not members, are included in its list of approved proctologists. Through the kindness of Mr St George B D Gray, of Hove, England, a list of members of the Subsection on Proctology of the Royal Society of Medicine was used. Six French and three German proctologists were included.¹⁷

Of the many replies received, fifty-seven replies gave definite information. Of these nearly all, *i.e.*, forty-nine, came from the American list of proctologists. It was agreed that the names of the individual contributors should not be mentioned in the final report so that each clinician might feel free to write with utter frankness about his own bad results.

Contemporary Practice—Nearly all of the correspondents, forty-nine out of the fifty-seven, gave statistics on their personal use of both operative and injection methods, thus indicating that they had had an honest desire to try out both methods without prejudice.

The total number of cases reported as treated by the two methods is. By operation, 36,648, by injection, 26,262.

Method of Choice—In reply to the question, "What is your method of choice?" answers were.¹⁷ Now use operation exclusively, 11, prefer operation but also use injections, 12, use both methods very extensively or choice depends upon the type of case, 18, injection is the method of choice, 16, total, 57.

Operative Methods—The methods of operative removal were. ligature and excision, 25,198 cases, clamp and suture, 2,570 cases, cautery, 5,779 cases, high frequency, 101 cases.

Injection Solutions—The solutions used for injection according to the number of proctologists using each are. Quinine urea hydrochloride (usually 5 per cent), 23, phenol in oil (usually 5 per cent), 11, both quinine urea H-Cl and at other times phenol in oil, 8, phenol in glycerine, 3, alcohol 70 per cent, 3, alcohol ergot and phenol, 1, double chlorhydrilactate of quinine and urea in glycerine 5 per cent, 1.

Types of Hæmorrhoids Injected—Should the third-degree hæmorrhoid, *i.e.*, the hæmorrhoid which prolapses and is not reduced spontaneously, be treated by injection above it? Twenty-six proctologists treat such hæmorrhoids by injection at least in some cases, twenty-two will not treat such cases by injection.

Site of Injection—Twelve inject above the hæmorrhoid, five inject at its upper border, fifteen inject into the hæmorrhoid and four both above and into the hæmorrhoid.

The above information as to contemporary practice is mentioned in order to make more intelligible what follows as to the results of treatment. It is

TREATMENT OF INTERNAL HÆMORRHOIDS

not offered as a guide to procedure—the best procedure can, of course, be learned only as we break away from custom and opinion and study the facts as to results. These facts follow.

Comparative Results by Operation and by Injection Methods—Statements regarding operation will refer to ordinary operative methods, exclusive of high frequency. The results from high frequency will be stated in a separate section.

Mortalities—In the 33,648 cases treated by ordinary operative methods there were no more than eleven mortalities.

In the 26,262 cases treated by injection there were no mortalities that could in any way be attributed to the injection treatments.

Sloughs following Injection—One proctologist, whose experience in injection methods was limited to fifty-seven cases, tried various solutions and reports sloughs following injection in every one of the fifty-seven cases. In 26,205 patients treated by forty-two other men there were 228 sloughs of importance. This makes a total of 285 more or less serious sloughs in 26,262 cases, or an incidence of about 1.09 per cent. How serious these sloughs were may be judged from the results as to hæmorrhage and stricture which follow.

Hæmorrhage—After operations on 31,950 patients there was serious post-operative hæmorrhage in 183 patients or 0.573 per cent.

After injections used on 26,183 patients there was serious hæmorrhage in seventy-three patients. Of these, twenty-eight were in the practice of the doctor who had sloughs in every one of his fifty-seven cases. Including these we have in the whole series a percentage of serious hæmorrhage after injection of 0.279 per cent.

Stricture—After ordinary operations stricture followed in sixty-eight cases out of 30,925, or in 0.22 per cent.

Stricture after injection methods occurred in six cases out of 26,183, or 0.02 per cent. Five of the six post-injection strictures occurred in the practice of the proctologist who reported sloughs in every case injected. The other case of stricture followed the use of quinine and urea hydrochloride.

Recurrences—Reports were given on recurrences at the end of three years. These reports are the least reliable part of the answers, indeed, the replies frequently stated that they were merely rough estimates. Out of 29,425 cases treated by hæmorrhoidectomy, the operators estimated that there were 148 recurrences, or about 0.5 per cent.

Out of a total of 9,691 patients treated by injection, the clinicians estimated that there were recurrences in 966, or approximately 10 per cent. Out of a total of 1,915 patients treated by injection in which replies indicated that careful work had been done in the follow-up, there were recurrences in 290, or in 15.14 per cent.

High Frequency—In considering the 3,110 cases treated by high frequency it should be understood that only 110 of these cases were reported by American proctologists. The other 3,000 were all treated by one French

surgeon In these cases there was one death which followed but which was not attributed to the high-frequency surgery Slight bleeding insufficient to require any medical attention occurred in 15 to 20 per cent of the cases Serious hæmorrhage occurred in 4 cases or 0.13 per cent There were no strictures following the high-frequency treatment Out of 3,000 cases followed for three years there were recurrences in 3 or 4 per cent and these recurrences were easily cured by two or three secondary treatments

Comparative Results after Various Injection Solutions—Phenol in Olive or Almond Oil—One correspondent volunteered the information that he had seen oily tumors and strictures which followed oil injections by other men, but gave no information as to whether they followed paraffin or vegetable oils nor as to the time following the injection that the oily tumor persisted On the other hand, another very conservative proctologist with an experience so large as to have covered 5,000 hæmorrhoidectomies in his own practice, volunteered "I have found no tumors as described by Rosser due to the injection of oil, although I am in accord with his findings"

Eleven proctologists who use phenol in oil exclusively and eight who use both phenol in oil and quinine urea hydrochloride reported no case of rectal stricture following injection of phenol in vegetable oil Four men who use 5 per cent phenol in oil exclusively in 2,067 cases report not a single serious slough, no strictures and one hæmorrhage

Quinine Urea Hydrochloride—Thirteen men who used quinine urea hydrochloride exclusively in 8,282 cases had twenty-three sloughs, seven serious hæmorrhages and one stricture If we consider separately the extraordinary report of one correspondent that he had made 5,000 injections of quinine urea hydrochloride without a serious slough, the report by the other twelve proctologists on 3,282 cases is twenty-three sloughs, five serious hæmorrhages and one stricture

Quinine Urea Chlorhydrolactate—The advocate of this solution, mentioned above, report that by using it and by practicing finger massage after injection, they have reduced the incidence of small sloughs from 10 to 15 per cent after quinine urea hydrochloride to less than 1 per cent with the chlorhydrolactate

Their formula is

Double chlorhydrolactate of quinine and urea	5
Glycerine	5
Water	100

Alcohol 70 Per Cent—The German proctologists in more than 240 cases treated with Bier's hyperæmia and then injected with 70 per cent alcohol, had no sloughs, no hæmorrhages and no strictures

Author's View—It may be of value in deciding as to how far personal bias on my part as collator of this material might unwittingly have influenced handling of the reports, if I state my own viewpoint frankly I use both operative methods and injection methods and decide between them after ex-

amination and after talking with the patient. Factors guiding the decision are the presence of other associated rectal diseases, the degree of hæmorrhoidal development, the age and general condition of the patient and at times the preference of the patient. Since I have found an operative procedure which prevents post-operative pain and hastens healing I have been using operation in more of the border-line cases.

Operation followed by Prolonged Local Anæsthesia—Sphincter and levator spasm associated with post-operative pain cause ischæmia in the site of the wound and delay in healing. Those who have injected a prolonged anæsthetic under an anal fissure know how relaxation of the spasm of the sphincter may allow rapid healing of the fissure. A situation similar to anal fissure occurs when an operative wound is carried across the mucocutaneous line. The problems of the newer drugs which cause prolonged local anæsthesia are beyond the limits of this paper, but I will mention that if such prolonged local anæsthesia is used, the anæsthetic need not be injected into the sphincter—it is necessary only that it be injected at the close of the operation in small amounts superficially under the wound chiefly where it crosses the mucocutaneous line. This measure, if added to well-chosen operative technic, should make the patient entirely free from pain for at least three days.

If the eucupin combination of de Takats¹⁸ is used, I advise that the eucupin hydrochloride commonly sold as "eucupin" should be avoided as it is too acid and lacks sufficient margin of safety from sloughing. The eucupin base (Merck) dissolved by adding dilute hydrochloric acid drop by drop to dissolve one part of eucupin base in one thousand parts of distilled water is more nearly safe.

If nupercaine is used it should not be boiled. I have found by animal experimentation that the statement of the manufacturers that it can be freely boiled without increasing the toxicity is untrue. There has been something wrong with some of the nupercaine solutions used which caused accidents. When I have used nupercaine solution even in the small amounts needed after hæmorrhoidectomy I have made it a rule not to use it until I have injected part of the sample intravenously in a rabbit in a sublethal dose.

Injection Methods—I have had small superficial sloughs following the use of quinine and urea hydrochloride 5 per cent into hæmorrhoids, which, while not of sufficient extent to be known to the patient, were annoying to me, and I now use better solutions which are more efficient and cause no sloughs. I have a low opinion of many of the solutions now commonly in use, which have too often been used on human subjects with no adequate preliminary experimental work until the recent valuable studies of Doctor Rosser. Safer and more efficient solutions should appear in the future.

High Frequency—Electrocoagulation followed by electrodesiccation is hæmostatic and causes less post-operative pain than the scalpel. The great objection to it is the difficulty in determining just how far the current is destroying tissue. I know of a case in the practice of another surgeon in which enthusiastic use of the high frequency caused extensive sloughing of

the anal canal with a dreadful result. High frequency if used at all should be used as the French use it, in small amounts at a time. In cases where operative removal in the hospital could not be arranged, and where injection methods were not likely to be effective because the hæmorrhoids were partly fibrosed, I have used it in the office with gratifying results, but inasmuch as the amount of tissue destruction is difficult to calculate, I urge that not more than one hæmorrhoid be treated at one time, and that even so, less treatment be given to the hæmorrhoid at one time than will probably be ultimately needed.

SUMMARY AND CONCLUSIONS

Arguments for operative removal of hæmorrhoids and arguments for injection treatment have been stated. A survey was made of cases treated by fifty-seven proctologists who, with the exception of a few foreign clinicians, were all members of the American Proctological Society or on its list of approved proctologists. This survey shows that in 36,648 cases treated by operation there were eleven mortalities and that in 26,262 cases treated by injection there were no mortalities that could in any way be attributed to the injection treatments. Hæmorrhage following operation was reported in 0.573 per cent of the cases and following injection in 0.279 per cent of the cases. Stricture following operation was estimated at about 0.22 per cent and after injection methods this group of men had practically no strictures at all. Recurrence of the hæmorrhoids was much more frequent after the use of injection methods, occurring in at least 15 per cent within three years.

Results from the use of phenol in olive and almond oil compared favorably with the results following the use of quinine urea hydrochloride. The double chlorhydrolactate of quinine and urea proved to be less likely to cause sloughs than quinine and urea hydrochloride.

It is probable that proctologists who are obtaining superior results would be more inclined to answer the questionnaire than those who are having poor results. The above figures show what can be attained in proctology at its very best. The general level of practice does not even approach such a high standard as has just been mentioned. Men who think that they can diagnose hæmorrhoids by digital examination, men who do not know the anatomy and pathology of the rectum, men who treat hæmorrhoids without making a proctoscopic and sigmoidoscopic examination, will continue to bring both methods into disrepute.

The long roster of contributors to this study would include a veritable hall of fame in proctology, and appreciation is due to these men, of whom many have international reputations, who disinterestedly toiled through their case histories to amass reports on these 62,000 cases.

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- ¹² Pennington showed that many of the common operative procedures, by ligature, clamp, or suture, close up and seal in, infection, and presented photomicrographs to prove this J A M A, vol 87, p 2064, December 18, 1926
- ¹³ The bactericidal properties of phenol 5 per cent in oil and quinine urea hydrochloride 5 per cent were investigated at my request by Mrs Winifred Russell, bacteriologist for Doctors Brem-Zeiler and Hammack Phenol in oil was found to be bactericidal to *B coli* in 25 per cent and quinine urea hydrochloride was found to be bactericidal to *B coli* in 5 per cent—not less
- ¹⁴ Rectal stricture following operation has in the past been reported in as high as 10 per cent of cases, even in large case series performed by proctologists of well-known reputation

E T C Milligan reported an incidence of 113 per cent stricture in a series of 282 hæmorrhoidectomies and in another series of 290 hæmorrhoidectomies an incidence of 9 per cent stricture (Proc Roy Soc Med, vol 23, p 702, March, 1930) In a recent personal communication, E T C Milligan adds "The series of cases I reported were the cases operated upon at St Marks Hospital in the years just preceding the publication and are a new series having no relation to those published by H G Anderson and Sir Charles Gordon-Watson previously They are group statistics and not individual, hence their value They are the cases of five surgeons—four surgeons performed the 'stripping up operation' and one performed 'clamp and cautery' It was interesting that the evidence of stricture formation was the same after the clamp and cautery operation Since abandoning the stripping up operation not one case of stricture has occurred, 450 cases"

Quoted and requoted from one medical journal to another are statements arguing for injection treatment and citing an incidence of post-operative stricture at St Marks Hospital, London, of 10 per cent Most of these quotations can be traced back to articles by H G Anderson (Brit Med Jour, vol 2, p 593, October 31, 1909) or by Sir Charles Gordon-Watson (Brit Med Jour, vol 2, p 593, October 15, 1921) The original articles have been most unfairly quoted, what they do say is "Forty per cent (of the ligature cases) had slight constriction easily remedied by digital dilatation, during the third week Five per cent had marked contraction requiring dilatation for six weeks All these did well later and showed no further tendency to constrict, and occurred in patients who neglected digital examination" Brit Med Jour, vol 2, p 593, October 15, 1921

Kantor in ninety hæmorrhoidectomies reports eight post-operative strictures and one case of sphincter paralysis (Am Jour Surg, vol 14, p 260, December, 1931) Vernon C David, who has an almost perfect record in his own cases, reports that of eighteen rectal strictures coming to him after treatment by others, ten were due to operation by clamp and cautery, four to the Whitehead operation, two to diathermy and only two to injection treatment J A M A, vol 98, p 1, January 2, 1931

¹⁵ Rosser also incriminates, but to a lesser degree, cottonseed oil as a vehicle. In a recent personal communication Rosser adds that these findings occurred in the case of cottonseed oil "when large doses are given" Rosser, Curtice J A M A, vol 96, p 1762, May 23, 1931, J A M A, vol 99, p 2167, December 24, 1932

¹⁶ Such an effort was made in the early days (1879) when the itinerant quacks were deliberately trying to slough out hæmorrhoids. Edmund Andrews who made the effort found that this method made a thorough study impossible. He wrote "Many of the operators were ignorant blockheads." In 3,304 cases "treated often in the most reckless and ignorant manner" four deaths occurred. (Originally Andrews reported nine deaths but later he corrected this statement, saying that only four deaths were authentic. Med Rec, vol 15, p 451, May 10, 1879.) There were eight instances of suspected embolism of the liver. Only one of them died and there was no post-mortem examination, so that positive proof is wanting. It is probable a portion of the cases the liver disease pre-existed and was the cause of the piles and not the consequence. a few cases only of extensive abscesses occurred." In the 3,000 cases "five cases of hæmorrhage are reported. The imperfection of the reports renders a thorough study of the accidents impossible." Cincinnati Lancet and Clinic, New Series, vol 2, p 327, April 19, 1879

¹⁷ Of these, five merely wrote in to give answer to this question and gave no statistics

¹⁸ de Takats, G Surg, Gynec, and Obst, vol 43, p 100, July, 1926

PRE- AND POST-OPERATIVE MANAGEMENT OF ANO-RECTAL CASES

AN INQUIRY INTO THE USE OF CERTAIN ANÆSTHETIC AGENTS

BY R. RUSSELL BEST, M D

OF OMAHA, NEBR

FROM THE DEPARTMENT OF SURGERY OF THE UNIVERSITY OF NEBRASKA

SURGICAL therapeusis has come to be the treatment of selection in a large number of diseases of the anus and lower rectum. In years gone by the exquisite pain that followed most ano-rectal operations was a definite drawback to surgery of this region. Failures in technic as well as in proper preparation and very likely a lack of interest in formulating plans to ameliorate the post-operative distress were the root of this evil. However, during the last ten years considerable advancement has been made in the reduction of post-operative pain in these cases.

In the pre-operative stage, cleanliness and proper preparation of the gastro-intestinal tube are most important. True asepsis is impossible in this region, yet it is a goal toward which one should strive, surgical cleanliness is about all that may be expected. In preparing for surgery of the lower rectum and anal canal, one should begin by giving a mild cathartic some forty-eight hours before operation to relieve any stasis along the gastro-intestinal tube, thus bringing the fecal material down into the colon where the pre-operative enema may be used to the best advantage. This cleaning out of the gastro-intestinal tract will also help to prevent post-operative distention and gas pains, and there will be less likelihood of a scybala forming. Some hours previous to operation a normal saline enema should be given until it returns clear. After the anæsthetic has been given, the rectum is thoroughly irrigated with a quart of 1 per cent Lysol solution. Using the index finger, with the aid of a small catheter or rubber-tipped nozzle, one can thoroughly clean the rectum and anal canal, removing any material from between the folds. A small amount of this solution may come down during the operation but the amount is usually negligible. I have found it much easier to wash out the rectum in this manner after a spinal anæsthetic because one secures better relaxation of the sphincter muscle. Gross dilatation and tearing of the sphincter will merely increase post-operative pain and spasm. Mercurochrome-acetone-alcohol solution is then applied to the anal canal and gluteal regions.

The selection of operation should fit the individual case. Certain types of operative manipulations and procedures are more apt to produce pain than others. For example the clamp and cautery operation for hæmorrhoids is bound to set up more painful stimuli than a clean anatomical dissection of the hæmorrhoidal tumors. In operating upon fissures and fistulæ, a wide

saucerization of skin plays an important part in the reduction of pain as well as giving a less distorting operative scar. I never pack a fistulous tract firmly but merely insert a small amount of gauze, which is removed at the end of twenty-four hours and never replaced, the wound being kept open by daily manipulation with a sterile gloved finger and applications of 15 per cent balsam peru in castor oil. It has never seemed necessary with my patients to insert a tube or catheter into the rectum following operations in this region. Such a rubber tube, particularly if surrounded by gauze, acts as an irritant and promotes peristalsis, thereby increasing pain and abdominal cramps.

It is the first act of elimination which all patients fear and precaution should be taken to reduce this pain to a minimum. If patients are kept on a liquid diet without milk for two days following operation, and such a time elapses before the first bowel evacuation and the lower canal is well protected, the danger of infection is greatly reduced. The amount of pain is in direct proportion to the degree of infection. As a protection for this operative area, one can use an oily substance which will coat over and soothe the area. This may be improved upon by adding some mild antiseptic to further encourage healing. The ideal substance would be something which, in addition to these qualities, possesses some anæsthetizing properties. Such an ointment I have been experimenting with during the last year. It contains both phenol and nupercaine (a hydrochloride of a butyl oxycinchonic acid diethyl ethylene diamide) in a vaseline base. Because of the possible toxicity of nupercaine and phenol, very small amounts of these drugs were used in the early cases. Gradually the amounts have been increased until now I believe the optimum results are being obtained, although it is possible that slightly greater amounts may be used without injurious effects. Further experiments will decide this issue.

Phenol is an efficient antiseptic and is a local anæsthetic to the extent that it will obtund pain although it does not obliterate all sensation. In such dilute solutions as 25 per cent to 50 per cent it will prevent the growth of staphylococcus pyogenes and the colon bacillus in some medias. Phenol is soluble in petrolatum and in an oily base becomes about one-tenth as active. It has been found that the lethal dose for a 150-pound is seventy-five grains (5 Gm), yet even five-grain ($\frac{1}{3}$ Gm) doses may give rise to serious disturbances. When phenol has been used in hæmorrhoidal injections with serious consequences, death has probably been embolic rather than due to the poison. In the later experiments the ointment was prepared by using ninety cubic centimetres (three ounces) of 1½ per cent carbolyzed vaseline which has been thoroughly mixed with thirty cubic centimetres (one ounce) of 1 per cent nupercaine ointment. In an ounce of this mixture there are 337 milligrams of phenol or approximately $\frac{1}{3}$ Gm. This may seem rather a large dose when it has been stated that five grains or $\frac{1}{3}$ Gm doses have given rise to serious disturbances. However, in hæmorrhoidal injections we frequently use ten cubic centimetres of 5 per cent phenol in almond oil.

Here we have 500 milligrams or $\frac{1}{2}$ Gm of phenol injected directly into tissue where it can be immediately absorbed. With the phenol in a vaseline base and introduced into the rectum, absorption is very much slower. Therefore, there is a wide margin of safety as regards the action of the phenol.

Nupercaine, or what is commonly known as percaïne in Europe, has undergone a great deal of investigation. It is known to be effective for local application to mucous membrane surfaces. The toxicity of nupercaine is high, exceeding even that of cocaine, but it is much more effective than cocaine in lower concentrations and is therefore used with less hazard, according to the reports of Gessner and Nauheimer, Lipschitz and Laubender, and Lotheissen. It is also said that nupercaine is slightly antiseptic. Hirsch has stated that as an anæsthetic agent a 1 to 2 per cent solution is as effective as a 5 to 20 per cent solution of cocaine hydrochloride. Coming in contact with blood-vessels, nupercaine causes initial vasodilation with subsequent contraction due to a drying effect.

For injections into the bladder, thirty cubic centimetres of a 1-500 solution may be used without hesitance. This amounts to sixty milligrams. For infiltration anæsthesia, 100 cubic centimetres of a 1-1000 solution is perfectly safe. This amounts to 100 milligrams. In preparing the ointment which I have been using, thirty cubic centimetres (one ounce) of 1 per cent nupercaine ointment is mixed with ninety cubic centimetres (three ounces) of the $1\frac{1}{2}$ per cent carbolyzed vaseline. Each thirty cubic centimetres (one ounce) of 1 per cent nupercaine ointment contains 300 milligrams of nupercaine. When this is diluted with ninety cubic centimetres (three ounces) of carbolyzed vaseline we have a $\frac{1}{4}$ of 1 per cent nupercaine ointment, which amounts to seventy-five milligrams of nupercaine in each thirty cubic centimetres (one ounce) of the mixture. This is well within the margin of safety even if this amount of nupercaine should be injected directly into tissue. When it is introduced into the rectum absorption is slower because the nupercaine is mixed with petrolatum and because all of the ointment is not in contact with the absorbing mucous membrane surfaces. The addition of phenol potentiates the action of nupercaine as it does with cocaine.

At the conclusion of all operations upon the anus and lower rectum, one ounce of this mixture is injected. The all-metal syringe is most useful for these injections. A small amount of the mixture is also placed upon the gauze dressing which is in contact with the anus and upon the small strips of gauze which are used in fistulous tracts.

The action of this combination ointment of nupercaine, phenol and vaseline is four-fold. First, both nupercaine and phenol have anæsthetic qualities and in an oily base the time element is prolonged. Second, they are both antiseptic, particularly the phenol. Third, the phenol is somewhat of a cauterant and probably tends to diminish oozing, and the nupercaine by its drying effect causes vascular contraction. Oozing is also retarded by the pressure and molding effect of the ointment in the lower ano-rectal canal. Fourth, in preparation for the first act of elimination, the lower end of the

intestinal tube is thoroughly anointed with a lubricant possessing anæsthetic qualities

Following operation, the patient is given a tube of 1 per cent nupercaine ointment without the phenol and it is applied locally as necessary for relief of any distress

As stated before, the patient is on a liquid diet without milk the first two days following operation. It is not my custom to give opium or bismuth or any other drugs to "tie up" the bowels during these first few post-operative days. Unless peristalsis is stimulated, the bowels do not want to empty after a rectal operation because of the reflex mechanism. Administration of mineral oil, plain or in combination with agar, is begun on the evening of the second post-operative day and is continued through convalescence or as advised.

After following these measures, the pain of the first bowel evacuation may be further minimized by an injection of six to eight ounces of warm cottonseed oil into the rectum on the morning of the third day. This may be supplemented if necessary by injection of a pint of normal saline.

Hot moist packs or dry heat may be comforting but are by no means routine measures. Hot sitz baths are advised after the first three days and may be continued indefinitely if desired. Doubtless the patient will require some morphine and codeine during the first few days and he should always be permitted to have a restful night.

When the patient is discharged from the hospital, in most cases at the end of five to seven days, he is advised to return on the tenth post-operative day and two or three times a week for several weeks thereafter, for digital ironing out and digital dilatation of the anal canal. This does a great deal to prevent painful post-operative spastic anus and stricture formation.

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THE PULSES OF THE FOOT

THEIR VALUE IN THE DIAGNOSIS OF PERIPHERAL CIRCULATORY DISEASE

BY RUDOLPH S REICH, M D

OF CLEVELAND, OHIO

FROM THE LABORATORY OF ANATOMY OF THE WESTERN RESERVE UNIVERSITY AND MOUNT SINAI HOSPITAL

INTRODUCTION —The recognition, in routine practice, of peripheral circulatory disease, particularly in the lower extremities, has been markedly improved of late years through more efficient differentiation of this condition from static foot disabilities Bueiger³ and others have called attention to certain definite signs facilitating the diagnosis of peripheral circulatory disease, the most generally used of which has been the palpation of the foot pulses in estimation of peripheral arterial circulation Since many cases have been erroneously diagnosed as peripheral circulatory disorder through apparent but not actual absence of foot pulses, this study of the arterial pattern and of the obscuring effect of superjacent soft tissues was undertaken to elucidate the problem

Diagnosis —The circulatory lesions have been so thoroughly classified by Brown and Henderson² that they require no further exposition than that given in Table I

TABLE I

Classification of Peripheral Circulatory Lesions

Functional or vasomotor types	Local distribution	Vasoconstricting types	<ol style="list-style-type: none"> 1 Multiple-phase color reaction Raynaud's disease 2 One-phase color reaction acrocyanosis, dead finger, local syncope
		Vasodilating types	Erythromelalgia
	General distribution	Vasoconstricting types	Primary or essential hypertension, early stages
		Vasodilating types	Primary or essential hypotension
Organic types	Local distribution	<ol style="list-style-type: none"> 1 Arteriosclerosis, with or without thrombosis, diabetic gangrene 2 Thrombo-angutis obliterans 3 Simple thrombosis or embolism 4 Arteritis of known infectious origin (rheumatic, syphilitic) 5 Aneurism with or without thrombosis 	
	General distribution	<ol style="list-style-type: none"> Arteriosclerosis 1 Primary 2 Secondary to hypertension 	

Whereas advanced circulatory disturbance is easy to recognize, the very early stage or mild case presents much more difficult problems of diagnosis. Buerger³ calls attention to the drop in local temperature and loss of natural color in the area affected by the occlusion. A clinical difference in temperature which may or may not be confirmed by the thermometer is pathognomonic of peripheral circulatory disease and if the disease is not very extensive, the toes alone show the sign. Elevation of the leg to 90° produces pallor and ischæmia, and the speed of return to normal circulation when the limb has been lowered is a rough measure of the disturbance. Samuels¹⁰ emphasizes the cadaveric pallor of the sole when the ankle-joint of the vertically elevated limb is alternately and rapidly plantar-flexed and dorsi-flexed.

There are several instruments of precision designed for study of the efficiency of the peripheral circulation. Among these are the oscillometer test

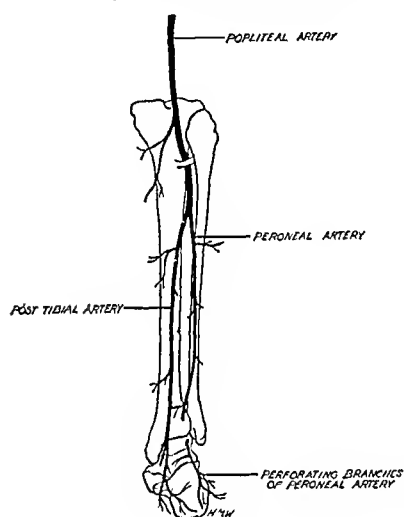


FIG. 2—Usual pattern of arterial tree in dorsal aspect of leg

which is somewhat analogous to the sphygmomanometer, the intradermal saline test of Stern and Cohen,¹¹ and the thermocouple as advocated by Brooks. All writers have referred to the pulses of the foot as a cardinal criterion of peripheral circulatory efficiency. Buerger³ considers absence of the dorsalis pedis pulse a very important sign in the diagnosis of peripheral circulatory disease since, in his experience, absence of this pulse occurs merely in one-half of 1 per cent of healthy feet. He bases this percentage on the examination of 200 known normal individuals. However, he quotes Erb as having found absence of the dorsalis pedis pulse in 2 per cent in the examination of 700 known normal individuals. In my observations upon 500 healthy individuals, I have found absence of the dorsalis pedis pulse in 4 per cent and of the posterior tibial pulse in 5 per cent. In a further 8 per cent a positive dorsalis pedis pulse was found in other than the common position.

VARIABILITY OF THE ARTERIAL TREE I. Dorsum of the Foot—Figs. 1 and 2 illustrate the arterial circulation for the dorsum of the foot and for the dorsal aspect of the leg below the knee as a basis for consideration of deviations from the usual pattern. These figures show the topographical relationships so clearly that no further exposition is necessary.

The observations comprised in this report were made upon the seventy legs of thirty-five white cadavera in the anatomical laboratory.

In one example only (1.5 per cent), the distribution illustrated in Fig. 3 was found. The anterior tibial artery subdivides at the usual site into a larger tarsal artery and a smaller dorsalis pedis which continues downward over the talus, navicular and cuneiform and then between first and second metatarsals, giving off, in its course, the first dorsal metatarsal branch and the branches to first and second toes. In this specimen the arcuate artery is a branch of the lateral tarsal. Owing to its small calibre the dorsalis pedis of

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this foot could easily be overlooked but a pulse would be palpated in the lateral tarsal artery over the lateral cuneiform bone

The next group of two instances (30 per cent) showed a complete absence of

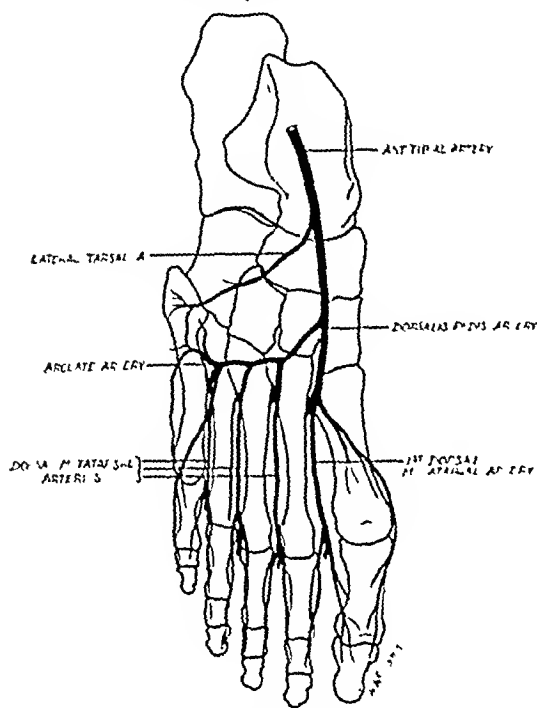


FIG 1—Usual pattern of arterial tree for dorsum of foot

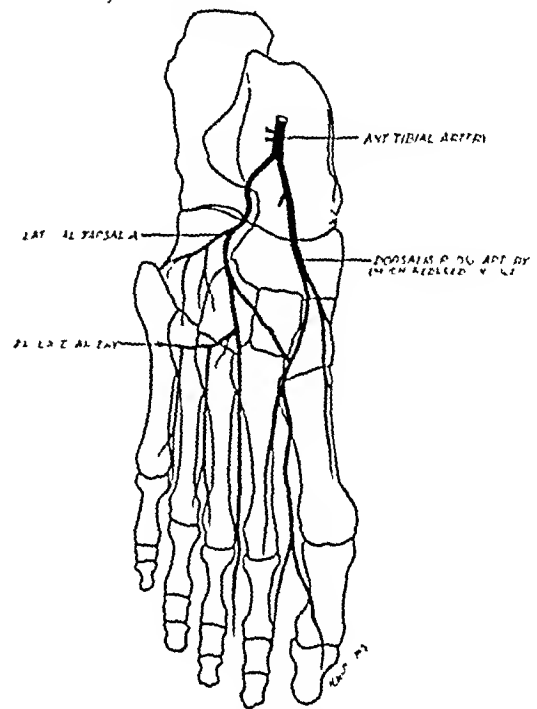


FIG 3—Pattern present in one out of 70 feet (15 per cent). Dorsalis pedis of small caliber. Lateral tarsal easily palpable

dorsalis pedis as an independent vessel. It becomes merely a loop in the arterial pattern of the dorsum. The first interosseous space was supplied in one specimen by the dorsal arterial tree (Fig 4) and in the other from the medial plantar artery

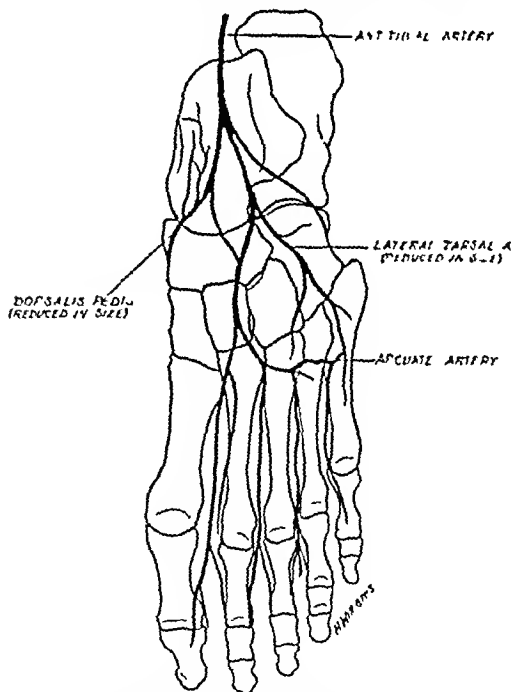


FIG 4—Absence of dorsalis pedis as an independent vessel (two out of 70 feet, 30 per cent)

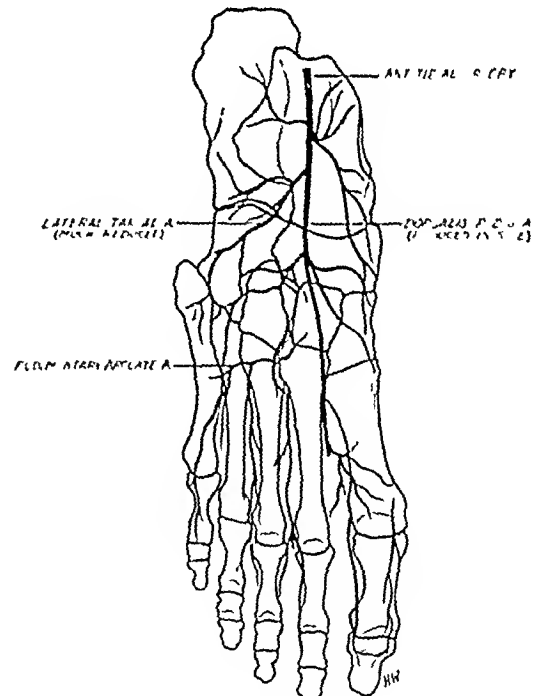


FIG 5—Reduction of anterior tibial and its branches with increasing participation of arteries of sole in supply of dorsum (30 per cent)

In two feet (30 per cent) the dorsalis pedis was not recognizable even as a loop and the anterior tibial continued downward as a central channel much reduced in size

The plantar arteries take a very prominent part in the supply of the dorsum the pattern of which becomes quite complex as its constituent channels are small and clinically non-palpable (Figs 5 and 6)

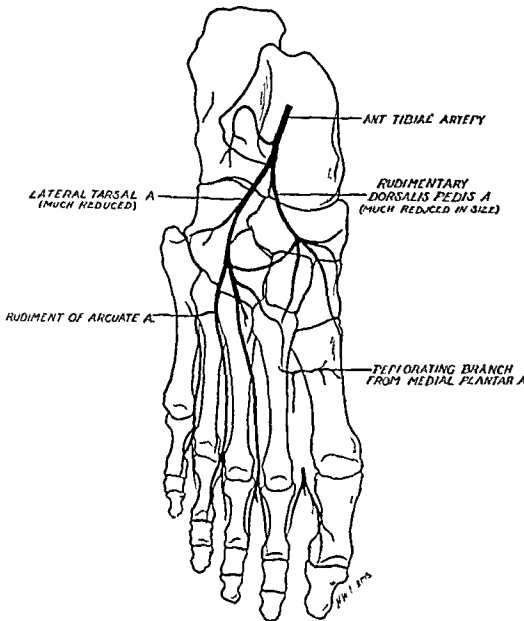


FIG 6—Variant of pattern present (Illustrated in Fig 5)

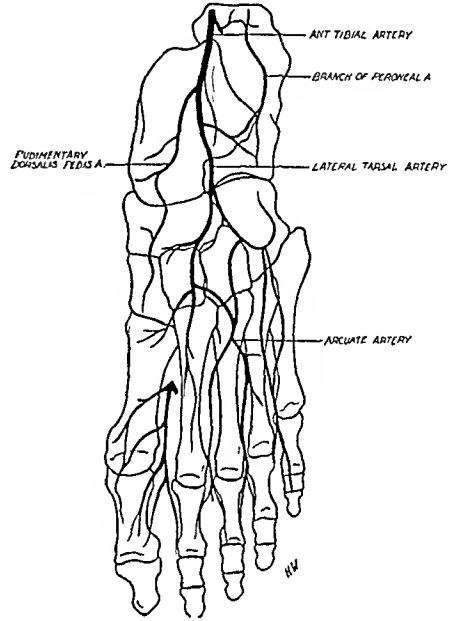


FIG 7—Participation of both anterior peroneal and plantar arteries in pattern of dorsum Dorsalis pedis rudimentary

In six specimens (90 per cent) we find an increasing participation by the anterior peroneal branch from the posterior tibial artery in the vascular pattern of the dorsum of the foot Fig 7 shows an early stage of this condition when the plantar vessels still

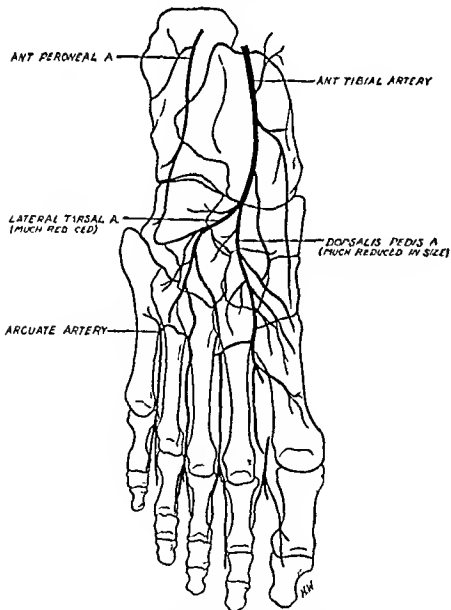


FIG 8—Increasing participation of anterior peroneal artery from posterior tibial

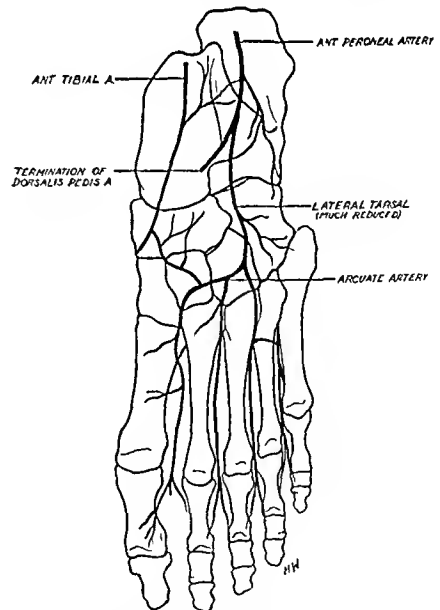


FIG 9—Anterior peroneal artery as chief source of arterial pattern on dorsum

take a prominent part and the dorsalis pedis together with the lateral tarsal and arcuate vessels are so small as not to be clinically palpable In Fig 8 the anterior peroneal forms a loop with the much reduced tarsal artery The plantar vessels are an important

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source of arterial blood to the dorsum in this specimen. In Fig 9 the anterior peroneal artery becomes the chief source of arterial blood to the dorsum of the foot. The anterior tibial is reduced to a mere thread and the contribution from the plantar vessels is meagre.

A very simple summary can be made of these variations obviously following reduction in size of the anterior tibial artery. The dorsum of the foot derives its arterial supply from three sources, namely, directly through the anterior tibial, from the plantar vessels, indirectly from the posterior tibial artery through its anterior peroneal branch. The anterior tibial vessel divides unequally into dorsalis pedis and lateral tarsal. The standard description figures the dorsalis pedis as much the larger but occasionally the lateral tarsal is found to be the predominant vessel. Reduction in size of the anterior tibial results in the participation of the plantar vessels through their perforating branches or of the posterior tibial through its anterior peroneal

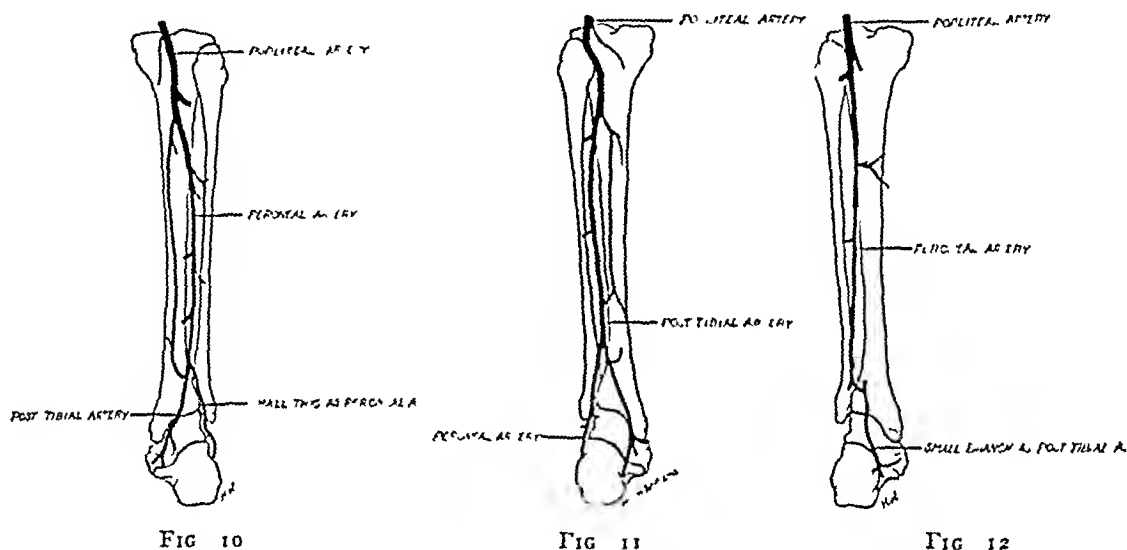


FIG 10—Peroneal artery forming the chief arterial trunk of the posterior crural region (1.5 per cent)
 FIG 11—A further stage in reduction of the posterior tibial artery in the calf (1.5 per cent)
 FIG 12—Practical elimination of posterior tibial artery as a vascular trunk (1.5 per cent)

division. Both these sources may be drawn upon. In this study, however, the anterior peroneal seems to play a greater part in the re-distributed pattern.

II Dorsal Aspect of the Leg—A study of the posterior crural region of the same seventy legs revealed the following significant anomalies, each of which, however, occurred only once (1.5 per cent).

The first of these, Fig 10, showed a popliteal artery bifurcating rather high into its two customary branches, of which the peroneal artery was obviously the main branch, while the posterior tibial remained as a channel of small calibre forming a long loop with the peroneal. After the latter had given off a small branch distributed as anterior and posterior peroneal vessels it continued downwards as the source of arterial supply to the foot, thus taking the place of the posterior tibial trunk.

In the second anomaly, Fig 11, the distribution is essentially the same but the posterior tibial loop is much smaller and both the channels which take the place of the regular posterior tibial and peroneal vessels are quite small.

The former anomaly would not result in an impalpable posterior tibial pulse but the second anomaly would have presented, during life, a really difficult problem of palpation.

The third anomaly, Fig 12, shows a complete attenuation of the posterior tibial loop except at the points where this loop joins the main arterial trunk formed by the posterior tibial. This vessel gave off a very small posterior tibial and a still smaller peroneal branch.

It is obvious that reduction in size of the posterior tibial vessels with its resultant effect upon the vessels of the sole can occur only in those legs the anterior tibial and dorsalis pedis of which are comparatively well developed. The result of this study is therefore the conclusion that the vessels of the leg below the knee present a pattern of a somewhat unstable character altogether different from that constant and very clear-cut picture which one obtains from the regular text-book description. Some explanation of this obvious contradiction must be sought if our results are in any way borne out by the careful observations of other workers.

Comparison of Published Observations—The literature gives no clear picture of the contribution to the arterial pattern of the dorsum derived from the anterior peroneal artery.

Out of 250 Japanese feet Adachi¹ reports 199 having a large dorsalis pedis; in nineteen, dorsalis pedis and lateral tarsal were both of approximately the same calibre; in twelve, the lateral tarsal was the principal vessel.

Among 200 Italian feet Salvi² found 137 in which the dorsalis pedis pulse was more palpable than the lateral tarsal; in thirty-five the lateral tarsal gave the main arterial contribution to the dorsum.

Corsy³ found that sixteen out of fifty new-born European infant feet showed a lateral tarsal artery much larger than the dorsalis pedis.

It is true that Salvi reports an incidence of 17.5 per cent of predominant lateral tarsal arteries, whereas Adachi records only 5.2 per cent and reports this difference as a true racial characteristic. From the difficulties of observation it might be equally probable that the difference is really more in the sample than in the human stock.

The peroneal artery, according to Adachi, is very often larger than the posterior tibial and such legs usually show a small anterior tibial vessel; the peroneal artery is indeed unusually constant. When there is extreme attenuation of the posterior tibial vessel it usually ends in the upper third of the calf by terminating as a muscle branch or as a nutrient artery of the tibia. Out of 486 Japanese legs the posterior tibial artery was very small in thirteen and absent in ten, a combined total of 4.9 per cent.

Among 211 English legs, Thane⁴ found the posterior tibial very small in seven and wanting in eleven when the peroneal, as expected, furnished the plantar artery.

Among sixty-six Italian legs investigated by Manno,⁵ the posterior tibial ended six times in the lower third of the leg by dividing into plantar and peroneal arteries.

Dubreuil-Chambardel⁶ found a diminution of the posterior tibial artery in eight out of 103 French legs.

The above observations, in summary, show that twenty-three Japanese legs out of 486 (4.9 per cent) and twenty-four European legs out of 277 (8.7 per cent) either possessed no posterior tibial artery or a vessel much reduced in size. The racial significance of this difference does not appear proven in view of the great variability to be found among the samples of different writers. These differences have been set forth in Tables II and III.

The Origin of the Arterial Pattern—The diverse and apparently bizarre variations in arterial distribution to the dorsum of the foot find their explanation in phylogenetic history. The anterior and posterior tibial arteries appear

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TABLE II

Arteries Dorsum of Foot

	No of limbs studied	Dorsalis pedis artery larger		Lateral tarsal artery larger		Dorsalis pedis artery small or absent		Lateral tarsal artery small or absent		Dorsalis pedis and lateral tarsal arteries absent	
		No %		No %		No %		No %		No %	
		No	%	No	%	No	%	No	%	No	%
Adachi	250	129	51.6	12	5.0						
Salvi	200	137	68.5	35	17.5						
Reich	70	52	74.0	5	7.0	10	14.2	8	11.4	3	4.2

TABLE III

Arteries Dorsal Aspect of Leg

	No of limbs studied	Posterior tibial artery absent		Posterior tibial artery small	
		No	%	No	%
Adachi	486	10	2.0	13	2.6
Thane	211	11	5.0	7	3.3
Manno	66	6	9.0		
Dubreuil-Chambardel	103			8	7.8
Reich	70	2	2.8	2	2.8

to be special features of human anatomy derived from the anastomosis of muscular vessels which carry the popliteal circulation into the lower leg. In primates the femoral artery is continued characteristically into the leg as the saphenous artery which accompanies the saphenous nerve and great saphenous vein to the region of the ankle.

This artery has been studied in recent years by Popowsky,⁷ who gives a summary of previous observations on the vessel and its termination. Popowsky points out that the saphenous artery descends quite superficially on the medial surface of knee and leg. In certain primates the vessel gives off a posterior branch which, descending behind the inner malleolus, gives origin to the plantar arteries of which the medial is phylogenetically the earlier developed of the two. The saphenous artery itself continues as the dorsalis pedis. After differentiation of the posterior tibial artery as a connecting link between popliteal and plantar vessels the peroneal artery makes its appearance by the continuity of an anastomotic chain. Still later, but in the same manner, the anterior tibial artery develops from an anastomotic chain connecting popliteal with dorsalis pedis. This phylogenetically new vessel reaches its full development in man alone in whom the saphenous artery is lost. Popowsky, however, found traces of it in two foetuses of five and six months, respectively. In these the saphenous artery terminated in the middle of the lower leg behind the saphenous nerve.

It is plainly due to the relatively recent transformation in vascular pattern of the human leg and foot that the arterial channels of the dorsum present so variable a character.

Clinical Application—Out of the seventy limbs studied fifty-two (74 per cent) had predominant dorsalis pedis arteries, the lateral tarsal artery was the larger vessel in five (7 per cent), in ten (14 per cent) the lateral tarsal was the main artery of the dorsum of the foot

Seven times in our series the dorsalis pedis was very small, it was entirely absent in three (4.5 per cent), the lateral tarsal artery was small in five (7 per cent) and entirely absent in three (4.5 per cent), in three legs (4.5 per cent) both the dorsalis pedis and lateral tarsal arteries were absent

Comparing these results with those of Adachi and Salvi I find myself in closer agreement with Salvi, particularly in the frequency of a larger lateral tarsal artery, for all my specimens were from white subjects

As for the posterior tibial artery, I find it absent in four legs (6 per cent) and very small in two (3 per cent) These results compare favorably with those of other European observers, notably Thane and Dubreuil-Chambardel, whereas in the Japanese, Adachi found anomalies of the posterior artery in approximately half this number

In white subjects one may safely conclude that the dorsalis pedis artery can be palpated in 75 to 80 per cent of lower extremities and the lateral tarsal artery in about 14 per cent In other words, approximately fourteen times in a hundred, if the dorsalis pedis pulse is not found in its usual location, one should feel for a pulse more laterally situated on the dorsum of the foot, approximately over the head of the third metatarsal bone

Both pulses of the dorsum of the foot are absent in approximately 4 per cent of European legs In these no pulse whatsoever can be palpated on the dorsum of the foot In about 4 per cent both dorsalis pedis and lateral tarsal pulses may be equal but much reduced in volume so that a dorsal pulse is found with difficulty and sometimes not at all

There is no posterior pulse in the 35 to 50 per cent of legs in which the posterior tibial artery is absent and in a further 3 per cent the pulse is very weak

Besides the arterial anomalies which make palpation of the pulse difficult or impossible there are two other important factors to be considered, namely adiposity and œdema In addition, the ligamentum laciniatum, covering the posterior tibial artery as it proceeds downward around the malleolus, may conceal this pulse even if the vessel is normal These factors exaggerate the frequency of non-palpable foot pulse

We may apply these results to the diagnosis of circulatory diseases of the lower extremity below the knee Presence of pulses of the foot rules out circulatory disease, absence of the pulses of the foot is an important aid in diagnosis if supported by other more positive evidence but in doubtful and border-line cases absence of the pulses of the foot must not be construed as a pathognomonic sign because of the relative frequency of obscured or irregularly placed foot pulses, a condition rendered still more confusing by the presence of adiposity or œdema

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Conclusions—(1) Whereas palpable foot pulses in dorsalis pedis or lateral tarsal arteries are contraindications of peripheral circulatory disorder, apparent absence of these pulses must not be construed as evidence of disease without the definite confirmation by positive signs

(2) Extracirculatory factors not infrequently diminish the ease with which the pulse may be felt. These are œdema, adiposity and the obscuring influence of superficial soft tissues, whether tendons or ligaments

(3) The arterial tree of the foot is sufficiently variable to throw doubt upon the value of negative evidence. Details of the anomalous patterns and their frequency are recorded in the body of this paper

(4) Both tibial arteries and the peroneal vessel are of relatively recent origin. They are formed from anastomotic chains of arteries supplying the muscles of the calf and ventrolateral aspect of the leg. In primates other than man the popliteal artery ends in muscular vessels while the vascular supply of the foot comes from the femoral artery through a vessel usually absent in man, namely, the saphenous artery, which continues as the arteria dorsalis pedis and gives off a posterior branch providing the plantar vessels to the sole

In man alone of all primates is found the complete pattern of new connections between popliteal artery and distribution on dorsum and sole of the foot. Hence the frequency and variety of arterial pattern described in the body of this paper

(5) There appears to be a racial difference in frequency since observations made by different investigators upon the feet of white subjects are in general agreement, whereas those equally carefully carried out by Adachi on Japanese feet present a smaller incidence though not a different classification. But one should beware of drawing positive conclusions of real racial difference since the frequency in random samples is apt to be determined by many conditions which are uncontrolled in investigations of this nature. The actual clinical frequency of circulatory disorder would be a more reliable criterion

(6) The anatomical structure of ankle and foot forces us to rely upon the arterial distribution of the dorsum of the foot for our information and the dorsum is clearly less significant as a source of general blood supply to the foot than is the plantar aspect, the arteries of which are too deeply placed and too greatly obscured by the heavy superficial structures to be available in diagnosis

Summary—Whereas palpable foot pulses in dorsalis pedis or lateral tarsal arteries are contraindications of peripheral circulatory disorder, apparent absence of these pulses must not be construed as evidence of disease without the definite confirmation by positive signs

Extracirculatory factors not infrequently diminish the ease with which the pulse may be felt. These are œdema, adiposity and the obscuring influence of superficial soft tissues, whether tendons or ligaments

Both tibial arteries and the peroneal vessel are of relatively recent origin. They are formed from anastomotic chains of arteries supplying the muscles of the calf and ventrolateral aspect of the leg. In primates other than man the popliteal artery ends in muscular vessels while the vascular supply of the foot comes from the femoral artery through a vessel usually absent in man, namely, the saphenous artery, which continues as the *arteria dorsalis pedis* and gives off a posterior branch providing the plantar vessels to the sole.

In man alone of all primates is found the complete pattern of new connections between popliteal artery and distribution on dorsum and sole of the foot.

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DISABILITY DUE TO SWELLING FOLLOWING TRAUMA OF THE EXTREMITIES *

POST-TRAUMATIC PERI-ARTICULAR FIBROSIS

By DONALD GORDON, M D

OF NEW YORK, N Y

FROM THE SURGICAL SERVICE OF THE FIFTH AVENUE HOSPITAL

THERE are many medical and surgical problems which by reason of their anatomical location have not as yet been made sufficiently clear by a pathological study of their histology and physiology to afford a complete understanding of the fundamental changes present. Such circumstances preclude the certainty for therapeutic measures that is afforded by diseases in which the pathological changes have been worked out sufficiently to develop specific indications for treatment. There is sufficient evidence in the historical past of deductions made from clinical observations in tissue reactions to warrant such observations being discussed today.

I propose to describe a common condition with the idea that though these observations as to its cause may contain errors, I may stimulate such work as will prove them false or develop a modicum of truth. From such truth as might develop, I would look for a better understanding of the late lesion with improvement in the treatment of it which is now unsatisfactory. From what I have seen clinically I do not feel under the necessity of apologizing for speaking of so simple and frequent a thing as swelling, and that which may follow it.

The disability due to stiffness of the fingers, with pain in the interphalangeal joints on movement, which follows the swelling incident to trauma or infection of the forearm, wrist, or hand, I think one will concede is not only a too frequent condition, but one that dramatically demonstrates function loss. I believe that a similar condition may, and does exist in the foot from the same causes. The loss of function in the foot following injury is not so graphic as in the hand, because of the lesser degree of mobility in the joints and the obscurity of visible coordinated movements which occur in the joints of the feet during function. However, if one will disregard the apparently small degree of lost joint action in the affected foot, and will judge function loss, as presented by painful joints in a limb bearing weight, there is added to the objective picture of a limp, an increase in the intangible subjective symptom pain, which starts the vicious cycle of muscle spasm, contracture, *etc*, and to emphasize any procedure which might prevent some of these should not be considered out of order.

My attention was attracted to this condition some years ago in the Out-Patient Department of the Roosevelt Hospital. It has been a subject of

* Read before the New York Surgical Society, October 25, 1933

intense interest ever since. An outstanding problem in our work was the swelling of hands and feet that occurred in cases of fracture and infections of the forearm, wrist, hand, and fingers. We noticed that in certain cases, such as children, adolescents, or young adults, this swelling disappeared in direct proportion to the improvement of the initial condition which caused the swelling, and no sequelæ followed. In still another group, most commonly in adults over thirty, though not necessarily determined by age, the swelling was followed by a condition of loss of function in the interphalangeal joints with pain on movement of these. These symptoms appeared late, and remained long after the condition for which the patient sought relief had been cured, provided a distinction was made between the original condition and the sequelæ. The latter is usually interpreted as part of the primary lesion, as the swelling which initiates the late process is a prominent symptom of the first. When the original condition is so treated and the sequelæ are prevented, the separation of the two entities then becomes evident.

In this ambulatory out-patient service, with the patient's limbs of necessity dependent for a considerable time daily, we made our dressings loose to prevent swelling from constriction. This did not prevent the process. We recognized the relationship of swelling, and in considering it as a cause we finally decided that there was an œdema distal to the œdema associated with the trauma, or infection of the primary lesion, and augmented by a dependent position of the limb which was different from the other œdemas. The former preceded the disabling sequelæ under discussion, and there was a direct relationship between the two in that when the distal swelling was absent or prevented, the disability did not appear, or did so to such a minor degree that the time of convalescence was not greatly prolonged.

When the opportunity of treating in-patients later presented itself, where closer observations could be maintained, and the results of continuous elevation in preventing swelling could be watched, I was impressed with the fact that meticulous adherence to the rule that the limb be kept above the level of the heart during the time when œdema showed any tendency to develop or persist, tended to prevent these incapacitating and undesirable joint changes which became more pronounced during convalescence from the primary injury. The heart level is used as it is a location which most patients know, and is a position in which lymph and venous return are aided to the greatest degree in the absence of muscle activity.

I feel at present that in the largest percentage of cases, if the condition develops, it is due to the fact that there has been either too great a trauma, or the directions for elevation and non-constrictive dressings have not been explicit enough, or insufficient attention has been paid to positively determine if adequate directions have been carried out, or rarely there is some systemic disease, focal infection, or dyscrasia which require other added measures of treatment.

The early studies were carried out on simple fractures, and as the essential features of the condition were better understood, the same principles of

treatment were applied to cases of infection occurring in these regions. The results obtained appeared to substantiate the hypothesis formulated as to the rôle that œdema played in the production of fibrosis around joints distal to an inflammatory process, but not proximal to it.

I have for several years called the condition post-traumatic peri-articular fibrosis, using this long term as one might use X Y Z in a problem until he can work out the unknown values. The reasons for the terms used are, it develops within a short time after a trauma, proximal to it, using the term trauma in its broadest sense, *i e*, chemical or physical injury which produces a local reaction of inflammation. Peri-articular because the outstanding and persistent lesion in the hand is a slight peri-articular enlargement which appears to be an expression of the most obvious cause that limits the movements of the interphalangeal joints. This limitation is proportionate to the local degree of the process and varies from no movement to a mere subjective sense that the fingers cannot close to make a fist without some degree of pain in these joints. Fibrosis is a questionable term to use in a condition the actual pathology of which is unknown. I have used the term to strengthen my assumption that there must be a peri-articular productive process which follows swelling and persists for varying periods after this swelling has subsided.

In treating cases, this term has emphasized to me that there is a type of swelling easily treated at one period, that if neglected and allowed to persist will leave a productive process to deal with which is disturbing to both patient and surgeon, and resistive to all forms of treatment.

In a certain mild group, it may be only a cell infiltration of the peri-articular structures of short duration which an improved state of circulation will clear up quickly. The extreme type is so slow in clearing up that I have felt that true fibrous changes could be the only explanation for the long period of convalescence, or the permanent fixation which may develop in the terminal joints.

Quoting Adam,¹ "Mere obstruction to the main lymphatic trunks from a part does not lead to complete stagnation of lymph, on the contrary, there is a continuous interchange between it and the blood in the capillaries. Nevertheless, there may be set up continuous and prolonged distention of the parts and this similarly is followed by fibrosis, diffuse in this case. Such appears to be the explanation of the commonest forms of elephantiasis, the fibrosis of macroglossia, and other cases of lymphatic obstruction whether congenital or acquired."

The question arises, is the œdema in the immediate vicinity of a fracture or infection the same as the swelling in the distal part of the same limb? I believe they are similar in some respects, but must of necessity differ in others. They are grossly similar if we look at the distention of the soft parts. They undoubtedly differ in intensity and local inflammatory signs. The proximal swelling of the lesion may be modified by elevation, while the distal swelling can usually be largely prevented. This is dependent upon

the nearness of the proximal lesion to the distal one. As the position of the proximal lesion advances towards the distal part of the limb, the contrast is lost between the two lesions, but even in such a case elevation will aid in the repair of the primary one, and in preventing the secondary one by improving the vascularity and lymph drainage of the part, provided a postural ischemia is avoided.

From a study of the œdemas, I cannot explain the productive fixation process following swelling. I believe the cause must be a complex one. It will not be worked out from the pathology of the mortuary, but must be developed from clinical and experimental work in which the various stages can be studied of changes in circulation, lymph, tissue cells, intercellular fluids, and hormone activity.

There is every degree between the mild and the advanced type of the lesion with the degree of pain of function proportionate to the severity of the process. At the stage of swelling, this pain is not marked, but as the generalized swelling subsides and leaves the enlargement about the joints, pain becomes prominent. Later the enlargement is not so marked as is the pain on movement. If complete fixation occurs in the joints, pain then stops. The cause of the pain I believe is not due to a neuritis with its pathological changes, but "due to the changes in the spatial relationship of the terminal sensory nerve endings" about the joint, when they are pressed upon by the increased pressure of the fibrous tissue upon extremes of movement. These joints are subject to weather change discomfort. I do not believe that the fibrosis is confined to the peri-articular tissue, capsule, and joint ligaments alone, but consider there is a lesser involvement of all the soft tissues which of necessity have to move on each other when a joint activates.

The clinical picture usually presented in the hand is as follows. A patient is treated for an injury or infection of the fingers, hand, wrist, or forearm. The hand becomes swollen. This is greatly increased if there are constricting dressings. If all dressings are removed, and the hand is placed in a dependent position, as in a hot bath, the position alone causes it, provided the position is maintained without periods of elevation. A forearm in loosely applied splints for a fracture, unless held elevated, will develop the swelling and this in direct proportion to the degree of the proximal injury. The soft tissues of the fingers become distended with fluid. This fixes or splints the interphalangeal joints, as blowing up a collapsed rubber toy balloon causes it to become firm. When the swelling has attained this degree, the fingers are held in a slightly flexed position of repose, the joint wrinkles and palmar creases are absent, the skin has lost its normal appearance, is pale or slightly cyanotic, and cannot be pinched up, the palm and fingers may be slightly moist. There are no changes in the nails or eponychium. The œdema is relatively a soft pitting one, and can be massaged out to a considerable degree. If this picture is allowed to continue for over a period of two weeks, or longer, or where the severity of the proximal lesion has diverted attention from the swelling of the hand or foot and it is permitted to exist, the swelling may appear to be less, but of a more stubborn type with the tissue about the joints more prominent. The eponychium at this stage becomes flattened, pale, and extends out on the base of the nail. The nails have the appearance of being unused, as to the finger pads. The fingers taper from the knuckles to the tips and look more pointed with the joints more prominent.

POST-TRAUMATIC PERI-ARTICULAR FIBROSIS

Active movements take place in the metacarpo-phalangeal joints rather than in the inter-phalangeals and a fist cannot even be started. The distal joints lose their function first, then the proximal ones, and lastly the metacarpophalangeal. As the development of the process progresses and matures, the degrees of function are always less in the distal joints. The pain is in inverse ratio, the less movement existing, the more pain there will be upon activation until fixation. Careful examination of each joint will show a few degrees of active and passive movement without pain, but to exceed this non-painful arc will produce pain in the joint proportionate to the extent that the joint is flexed. This is not due to the fixation of the tendons in their sheath by plastic exudate, as each joint shows varying degrees of movement. There is no pain or crepitus in the tendons, and unless the insertions of the tendons which are so closely related to the capsules be part of the picture, it appears to me that the tendons have little to do with it. Limitation of motion apparently is due largely to a peri-articular productive process which is slightly tender on firm pressure and causes pain when extremes beyond non-painful arcs are exceeded. The process in severe cases may extend to the carpal or wrist-joints.

Making due allowance for the difference in the anatomy of the foot as mentioned before, the loss of joint movement is not graphic, but if one will visualize an analogous painful process in the joints of the feet, the discomfort of moving these joints in walking can be appreciated when these members have to support the body weight.

The condition likely has been called many names, and the cause ascribed to as many others, but I am unable to find a concrete description of it. Traumatic arthritis might seem an appropriate name, but this term conveys the idea that these joints have been the site of the original trauma, whereas they are a complication, or sequela as you please, of an injury, proximal and at some distance from the affected point. There is no synovial effusion, no joint crepitus, and they do not present the picture of having been injured. They are not infections unless affected by the presence of focal infection elsewhere, and they do not show the redness of the skin of acute inflammation.

X-ray shows early and prolonged decalcification of the bones with slight increase in the density of the peri-articular tissues. The bone decalcification is a most persistent part of the picture and requires more than "atrophy of disuse" to explain it. The muscles activating these joints undergo an atrophy of disuse which is added to that produced by the primary injury.

Among the œdemas which do not cause it are generalized anasarca, œdema of the legs or arms unassociated with injury or infection, ligation of the vessels of a limb, a severance of nerves, sensory or motor, excluding trophic disturbance, unless the associated injury is severe. The nearer to the trunk the primary lesion is, the less apt are the sequelæ to cause stiffness in the hands or feet.

As the most common œdemas do not produce this condition, may we not suggest that in an œdema of the distal part of a limb secondary to trauma, something is activated which produces the disturbance in cellular activity in the distal tissues dependent upon lymph stasis and circulatory changes, which ultimately causes a fibrosis at a point of meager vascularity about the joints. The prevention of lymph stasis and circulatory changes will avoid this causative factor.

Differential diagnosis must exclude fixation of tendons either in an infected or adherent scar, or to adhesions in their sheaths. Acute exacerbation of a chronic arthritis, or the more rare Neisser infection must also be ruled out.

In cases of chronic arthritis, this condition due to injury may present itself and aggravate the former. In itself, it is a multiple arthritis, and any case which has an arthritic background should be carefully guarded against its development.

Volkman's contracture can be readily determined as a muscle lesion, but the etiological factor which produces a Volkman's pathology may produce the peri-articular one, and the added difficulty of treating and regaining lost muscle action when joint function is absent, becomes obvious.

Treatment—I am firmly convinced that this condition can be prevented to as large an extent as many of our so-called preventable diseases are prevented at the present day. I am also fully convinced that whatever the unknown values of XYZ proves to be a recognition of the possibility of such a condition supervening in any trauma of an extremity together with the possibility of its prevention or mitigation by suitable measures makes it incumbent on the medical attendant to add to local treatment such measures as will tend to prevent its onset.

It is prevented by taking care that such swelling as might follow or accompany any trauma or infection of a limb is kept down to a minimum degree until the cause of the swelling has subsided. If this is done, muscular action will facilitate and tend to overcome capillary and lymph stasis. If the increased lymph pressure in the extremity is prevented, the capillary circulation is improved as can be demonstrated on any open granulating wound. Rings should be removed, or cut off the fingers. Dressings surrounding a limb should be neither constrictive nor applied so that they cannot be released sufficiently and quickly to stop the onset of swelling due to these. Adequate cotton padding should be placed on splints, about, and between dressings and bandages to permit a safety factor against swelling and constriction. Fractures should be reduced to a satisfactory position at the earliest possible moment. Localized infections and incompletely drained pus pockets should be opened at the earliest possible moment. Infections which are unlocalized should be given hot baths or local moist heat with elevation judiciously and energetically applied until the œdema has subsided or the infection localized. Dressings should not be applied dry and afterwards wet, as the bandages shrink when moistened.

Adequate splinting of trauma or an infection avoids the spasm of muscle splintage and promotes more comfortable voluntary activity of the fingers and toes. In reapplying splints which have been removed to permit massage for swelling, care should be taken to avoid rebandaging them as tightly as before removal.

The most important feature is that the distal end and as much of the whole extremity as is possible be maintained as high as possible above the

level of the heart until all tendency to swelling has subsided. This obtains in either the sitting or supine position. Where this is not effective, gentle massage by a masseuse or the surgeon with the dressings removed, must be used to combat the swelling of the fingers or foot.

An ambulatory patient with elbow flexed and hand on chest above the heart is in an incorrect position, though in a better one than hanging down with the forearm horizontal. There may be frequent brief periods of respite during the day from these elevated positions to afford increased circulation for repair. The presence of finger and toe-joint creases and wrinkles at all times is imperative. If elevation does not afford this picture, the dressings are too tight and must be loosened as soon as possible, or there may exist increased tension from undrained infection. The surgeon who uses dressings which cannot be loosened without his personal attention should arrange to cope with this problem before it is too late. Non-padded split plaster encasements fulfill this dictum for plaster dressings.

The apparently simple procedure of getting either an interne, nurse, or patient to understand the importance of carrying out directions for sufficient elevation is a most difficult and arduous task. They must be given specific illustrations as to the method, and this followed with daily, I might say, hourly observations until the patient can be made to understand what is wanted, what is effective, and what is not effective.

The persistence for only a few days of a very moderate degree of swelling will initiate the process, especially in a certain type of individual. I have no means of identifying this type, except age is a predisposing factor. What can be prevented will not have to be treated, but once it is established, the outlook is one of prolonged convalescence lasting for months. Recovery will not take place for a period of eighteen months. My experience has been that most cases clear up, the severe cases being left with one or two ankylosed terminal phalanges. In the very painful cases a splint will give comfort. The case that is established should not have any massage which does not give an immediate beneficial reaction without pain. Passive movements by a masseuse or with the patient's free hand which cause pain are very bad and augment the condition. Hot moist baths for fifteen to thirty minutes with non-painful active movements are excellent. Elevation should be continued high and positive, so that when the limb is depressed to improve circulation, the blood may surge into the capillaries as in Buerger's exercises. Other physical measures I refer to the physiotherapist. When the process permits resisted movements, if these are used in the planes of lost motion, they will be a great aid to the restoration of function. Movements should be given after the hot baths.

Physiotherapy will seldom be needed where the elevation has been adequately carried out from the inception of the original injury, but where the process shows a tendency to develop, and this form of therapy is available, it should be used under the supervision of not only the physiotherapist, but one who understands the lesion. It is a valuable aid in the severe and late

cases, not only for the local comfort, but for the assurance that something is being done during the long convalescence

Occupational therapy or light work which causes no increase in pain or stiffness is a real aid in the late case where the pain is little and the stiffness great

A word of caution is necessary in treating the established severe case. The literature contains suggestions regarding treatment of what appears to be analogous conditions, but such treatment is usually applied for some one feature of the whole. As the whole tends to get better with time, my suggestion is to avoid radical measures for any specific changes in a self-limited condition until more definite knowledge exists of the relationship these have to the actual picture. Above all, do not look for any miraculous recovery. The unbelievers may reverse what I have advised against and watch the development of the condition.

Discussion of some views on the relationship of œdema to fibrosis would seem in order. Adam,² in the Middleton-Goldsmith lectures, March, 1896, delivered before the New York Pathological Society on "The Relationship Between Inflammation and Sundry Forms of Fibrosis," gives an excellent exposition on the occurrence of overgrowth of connective tissue in the body and theorizes on the causes of such changes in various organs. His views were based on clinical, pathological, and experimental work, and though these lectures were delivered some time ago, they are most interesting in connection with this subject. He defines inflammation "The series of changes which constitute the local attempt at repair of actual or referred injury." He then states, "Take in the first place chronic obstruction to the flow of lymph, where such obtains whether by pressure of tumors on the main lymph channels of a part, blocking the same, or by diseased states of the lymph glands, it is a matter of frequent observation that *in the absence of satisfactory collateral tracts* the parts become swollen and gradually the fluid swelling gives place to a generalized if not very extreme connective-tissue overgrowth. *In such cases the circulation of the blood through the affected area is maintained*" (Though he does not state to what degree.) "There are no positive signs of inflammation evident either macroscopically or microscopically. We cannot recognize in the condition an attempt at repair. The primary injury has been at a distance from the region of fibrosis. Nevertheless, it may be argued that the stagnating lymph acts in these cases as an irritant to the connective-tissue cells, and that the condition must be regarded as a productive inflammatory fibrosis." He later states, "Where there is any force in action tending to draw apart, and pull upon the constituents of the tissue, whether the force acts from without or (as in cases of increased effusion of lymph) from within the tissues—when, in short, there is a strain upon the components of the tissue, then, if we regard the work of the connective tissue, as is most plausible as having to bind together and support the other tissues, undoubtedly that work is increased and granting that at the same time the nutrition remains good, we have a condition favorable to increased growth. *A fortiori* we might expect such hypertrophy when simultaneously the amount of nutrition is increased." Matas,³ in a paper entitled "Surgical Treatment of Elephantiasis and Elephantoid States Dependent upon Chronic Obstruction of Lymphatic and Venous Channels," sums up the requisite etiological factors for producing such conditions as follows:

- (1) Mechanical obstruction or blockage of the veins of the region, usually an obstructive thrombophlebitis, or lymphangitis, or adenitis
- (2) Hyperplasia of the collagenous tissue of the hypoderm
- (3) Gradual disappearance of the elastic fibres of the skin

POST-TRAUMATIC PERI-ARTICULAR FIBROSIS

- (4) The existence of a coagulable dropsy or hard lymph œdema
- (5) A chronic reticular lymphangitis caused by secondary and repeated infections of pathogenic microorganisms of the streptococcal type

It seems rational to believe that in the pathological problem of stiff fingers following an œdema caused by a simple fracture of the forearm, that one might exclude infection entering the picture unless as a distinct focal infection. In such a case, I would be unwilling to believe that the focal infection had any relation to the cause of the lymph stasis. I can readily understand that a focal infection could influence the final joint lesion after it was established, and this may be a cause for the persistence of the process in a small percentage of cases. It is a striking fact that this lesion does not develop in children, from the same degree and duration of stasis, with or without infection, as it does in the adult. In children we have to consider the time period that interrupted lymph channels might take to reestablish adequate channels to remove œdema and the greater vascularity of the growing child as compared with the adult.

Unquestionably, in the œdema distal to an infection, some or all of Matas' postulates must hold true. This would seem to be substantiated by Homans' work on "Thrombophlebitis of the Lower Extremities," where he gives examples of the overgrowth of connective tissue following prolonged lymph stasis, due to phlegmasia alba dolens, which he calls "post-phlebitic indurations," and ascribes it to lymphatic obstruction rather than venous. He describes the dense fibrous-tissue formation which extends in the subcutaneous tissue down to, but not into the muscles of the leg.

Antedating Homans, Halsted⁵ assigned undue tension on the lateral flap in closure of the operative wound following radical mastectomy together with infection as a cause of early swelling of the arm, and recurring infections as a cause of the late swollen arm. He concurs with and gives praise to Matas for the latter's infectious theory of elephantoid states.

Although œdematous arms following radical mastectomy are not infrequently seen as having persisted for long periods, I have never seen a case where the fingers had lost their mobility except by simple distention of the soft parts.

Halsted⁶ refers to the work of F. L. Reichert, Mont Reid, and C. Y. Bidegood in replanting a limb in which the femoral artery and vein had become totally obliterated seven months before. These experiments were conducted to determine the amount and duration of the swelling which would follow division of all the lymphatics and veins of the thigh. Swelling occurred but subsided within a ten-day period. Reichert⁷ showed in the dog, after complete severance of all tissues of the thigh, except the bone, artery, vein, and nerve, followed by resuture, regeneration of lymphatics was demonstrable in four days after operation. The superficial and deep lymph vessels at eight days were physiologically adequate. "Concurrent experiments have shown compensatory arterial and venous regeneration occurs by the third and fourth days respectively. In two to twenty weeks the main lymphatic trunks had frequently united." Swelling lasted up to the tenth day, or a few days more following ligation of the femoral vein and then subsided. Regeneration of lymphatics was delayed by infection or scar tissue.

None of these authorities has reported on the condition of the fibrous tissue in the extreme ends of the limbs, either there was not a disabling overgrowth if any occurred, or attention was not attracted to it. Peri-articular fibrosis in the hand and foot as a sequelæ of a proximal infection would seem to have a strong background, as dependent upon lymphatic stasis.

The cause of peri-articular overgrowth of fibrous tissue following lymph stasis in the non-infected simple fracture I am at a loss to explain.

Clinically, a dependent limb has a greater venous and arterial capillary

pressure The same limb distended with œdema has relatively a smaller amount of blood in it

The overgrowth of connective tissue in the hands and feet distal to a proximal trauma may be due to a local attempt to repair an indirect injury, as suggested by Adam, the injury being an unsupported distention of the tissues, the overgrowth being stimulated by either a superabundance of normal lymph or a changed lymph due to temporary physiologically incompetent lymph channels in the presence of a diminished vascularity, as is observed in the hypertrophied scar

The fact that the lesion is prevented by elevation suggests that lymph stasis sufficient to promote fibrous tissue overgrowth is avoided until the lymphatic and vascular injury has had time to regenerate and become physiologically adequate

This hypothesis merely affords a principle for preventive treatment, but does not satisfactorily show the true cause, nor does it furnish a suggestion for the treatment of the established process

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THE STUMP OF THE APPENDIX, AN AGENT OF INFECTION

BY ROBERT M. HARBIN, M.D.

OF ROME, GA.

FOR practical purposes appendectomy should never be considered clean surgery for the reason that the mucous membrane of the stump of the appendix is part and parcel of that of the colon which in surgical parlance is proverbial for its infectivity. The menace is further increased by a devitalization of the stump from crushing, cautery and ligation. In the discussion of the unchanging mortality of appendicitis this factor seems to have been ignored, and improvement in this regard requires a revision of some of our cherished convictions. There is no operation in surgery that offers so many unexpected infections as that of appendectomy, and as a result the operating-room supervisor and sterilizing equipment are at times arraigned unjustly for supposed breach of aseptic technic in which accusation surgical conscience seems to rest.

A pathological study as to the type of infection of the mucous membrane in question has little practical bearing on the fact of infection which must be accepted as a challenge to ascertain the modifying factors. While such residual infection cannot be annihilated, there can be brought to bear certain methods for conserving such infections.

Pioneer surgeons thought it very important to peritonealize the stump by dissecting off a cuff to cover same, but trauma and infectivity soon became in evidence. Inversion without ligation was then tried but hæmorrhages became too frequent. Following this experience ligation and infolding of the stump was adopted and is still a popular method with many good surgeons. The "open drop" method, however, seems to be the choice of a majority of surgeons and escapes the occasional menace of pent-up virulence and invites an open early and gradual fight with the remarkable conservative powers of the peritoneum. Unexplained post-operative temperatures are frequently an evidence of this process. Initial infections are as a rule comparatively mild when compared with the virulence developed within a few days, especially when the infolding method was adopted. As such pent-up infection cannot be discharged into the colon, it must burst into an unguarded peritoneum which has not had time to build up protective adhesions. Operative findings warrant the belief that in the observations of infection, virulence can be judged not so much by gross appearances as by the duration of infective processes for the peritoneum can fortify itself against a great degree of infective activity if given sufficient time to build such fortifications. It has been observed that synergized infections in the peritoneum develop a greater degree of virulence than follows a more simple type and the time element becomes an intensifying factor.

When we bear in mind these considerations, one method of treating the stump is about as good as another provided it is handled with meticulous care in avoiding contamination. Our rule has been to use iodine after ligation and excision and swab out the lumen of the stump and then apply a taped sponge and return the cæcum to its original position where it remains until the peritoneal sutures are well-nigh completed.

Primary infections of the layers of the abdominal wall are rarely serious and only become so secondarily from deeper infections and according to Schumann, in the presence of modern aseptic technic, practically all unexpected serious infections proceed from within. Quoting from Herman¹ the resistance of the peritoneum to infection is three or four times that of the skin and layers of the abdominal wall.

It is not a radical policy for every case of appendectomy to be treated for two or three days as peritonitis for such is the case in miniature. Such treatment is no harm to the case that would recover without it, and the treatment may be summarized: morphine and great restriction of fluids by mouth which reduce the peristaltic wave to a minimum. That means negligible vomiting and tympany which tends to aggravate border-line infections. The bugbear of acidosis frightens many surgeons into the menace of meddlesome post-operative treatment for acidosis *per se*, like fever, has little significance aside from its etiology and in the absence of active infection rarely follows the restriction of fluids by mouth. Any use of purgatives before the end of the third day is likely to defeat the effort for immobilizing the peristaltic waves, for within this period of time the fate of these early infective processes will have been determined. The free use of fluids by mouth and any kind of purgations in the first two or three days defeat the object for which they are given and instead of preventing acidosis such efforts invoke a toxic element through stagnation so that less water is finally metabolized.

Our own statistics² show that the mortality rate for females (27 per cent) is 1 per cent less than that of males (37 per cent) and this difference is probably due to the fact that the peritoneum of the female is more resistant to infection because more innervated to the absorption of bloody fluids incident to menstrual cycle.

ACUTE APPENDICITIS										
Total		Non-Resident		Within		Closed		Drainage		
				24 Hours		Incision				
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Harbin										
Hospital										
1911-1931	1080	31	669	27	336	0	669	1	411	30
		2.8%	62%	4%	31%		62%	0.1%	38%	7.3%
Eight										
Atlanta										
Hospitals										
1927-1931	4270	188	388	16	1827	30	3411	129	809	59
		4.4%	9%	4%	42%	1.6%	82%	3.7%	18%	7.3%

The ever-present potential infection in the stump of acute and chronic appendicitis at times becomes activated through unavoidable surgical trauma and this hazard should have due consideration more especially in the post-cæcal type

The perennial question of drainage in acute appendicitis, like Banquo's ghost, still confronts us and is treated by many surgeons as a closed issue and by others as a matter of personal taste and by all as an insult to surgical pride. Such an attitude of surgical practice requires critical analysis in a larger field of study in which any one man's observations cannot be final. With this in view we have compiled statistics of acute appendicitis of many operators in standard hospitals³. The question of drainage can in my opinion be better settled by a study of mortality rates of closed incisions. In this table two important differences may be noted. First cases of operations within the first twenty-four hours 336 (with 12 per cent drainage) with zero mortality in the one and 1,827 cases in the other with a mortality rate of 1.7 per cent. Second a smaller rate (62 per cent) of closed incisions with a mortality rate of 0.01 per cent in the one and a rate of 82 per cent and mortality rate of 3.7 per cent in the other. It is reasonable to believe that the differences in this comparison hinges to a great extent on the different viewpoints of dealing with the appendiceal stump. So in these standard hospitals it is fair to conclude that the drainage and mortality rates maintain somewhat of an inverse ratio.

The pioneer surgeons were wont to either close the incision or else leave it entirely open without sutures using glass or solid rubber tubes with a superficial pack. This was rather an ultra-safe technic so far as drainage was concerned, but post-operative hernia was frequently in evidence. A valuable compromise between these two extremes developed in the use of fenestrated rubber tissue tube (without gauze) drainage with closure of incision to the angle, and this technic incurs no mechanical obstacle to peristalsis and a great degree of capillary drainage is furnished by flat surface in the presence of intra-abdominal pressure. In every suspicious case the pelvis should be searched for pocketed serum pus accumulations. This rubber tissue tube should be a third longer than the distance to the stump then the tube will not be shortened by deflection from the peristaltic wave and distended coils of intestines. I belong to the school of surgeons who still believe in draining when in doubt. This rule enables one to observe a minority of cases of drainage without harm in border-line cases that prove to have been unnecessary as evidenced by a scanty discharge and in many instances checked as sterile and I do not believe that such drainage makes infection but rather accentuates a latent type that promptly becomes disposed of. However, in the majority of cases of drainage of border-line infections, there is a profuse serous discharge in evidence that is unquestionably not due to the presence of a rubber tissue tube. In every surgical repair within the peritoneum there is poured out more or less serous effusion which would ordinarily be absorbed unless some potential infection becomes provoked, and

the first stage of preventing such infection would be to remove the pabulum upon which potential infectivity would thrive. While many such frank infections readily localize and discharge spontaneously through the incision they do so with greater degree of average morbidity and damage to the strength of the abdominal wall than would follow primary drainage to the stump of the appendix. It is needless to urge that a superficial drainage could not necessarily prevent a pocketed or spreading infection around the stump and of course it would be useless to drain in the presence of an enfolded stump.

SUMMARY

(1) For practical purposes an appendectomy should never be regarded as clean surgery.

(2) Potential infection subsists in every treated and devitalized stump of the appendix.

(3) The "open drop" method, safeguarded temporarily by a small, taped sponge, avoids pent-up virulence of infection and promotes an early open fight with the conservative processes of the peritoneum.

(4) Drainage when in doubt will conserve directly and indirectly a great degree of average morbidity and occasionally prevent a death that would otherwise occur in a closed incision.

(5) The rubber tissue tube drainage tube without gauze to the focus creates a negligible interference with the peristaltic wave.

(6) The conservative processes of the peritoneum are facilitated by efforts at indirect immobilization of peristalsis by reducing the oral intake of fluids to a minimum along with morphine for the first three days.

(7) In well-organized clinics comparative statistics by the thousand cases showed that in one series the rule of drainage, when in doubt, was adopted with a drainage rate of 38 per cent, with a total death rate of 28 per cent, while in other clinics with a drainage rate of 18 per cent there was a death rate of 44 per cent.

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DRAINAGE AFTER OPERATION FOR APPENDICITIS

CHIEFLY ON THE REMOVAL OF DRAINS

BY CHARLES ROY DAVIS, M D

OF DETROIT MICH

THE question of drainage in appendicitis is still not sufficiently settled so that the procedure can be said to have become standardized. Each surgeon thinks that his method of drainage is the correct one. When I read an article by Dr F C Warnshuis¹ on appendicitis I was made to think that perhaps my method of removal of drains is wrong. He stated that the drains must not be removed until they are ready to float out almost by themselves. Deaver² also says that the drain should stay until it falls out. Many other surgeons follow this procedure at the present time but usage does not necessarily mean that the method is correct or advisable.

We were taught (Cornell 08) that a sinus or tract was formed about a drain in four hours. When I was an interne at Presbyterian Hospital 1908 to 1910 drains were removed very gradually a little each day. The sinuses which followed this method of removal frequently needed irrigation the care which they demanded forced me to wonder why we were taught that four hours were sufficient for the establishment of a drainage tract and why we practised as we did. I also saw faecal fistulas following the method then in use. If our teaching were correct the method could be changed, and much hard work could be saved. When I was house surgeon I made this change and have followed a fairly consistent method of handling drainage for twenty-two years.

As a rule the type of drainage has consisted of a split rubber tube with an iodoform gauze strip inside inserted to the pelvis and a cigarette drain with an iodoform gauze centre inserted either to the abscess cavity or to the site of the appendix. If the cavities were well walled off the drains were inserted into the cavities only. Variations from this technic have consisted in two tubes or two tubes and a cigarette drain or occasionally three cigarette drains, but by far the greatest number of cases received one tube and one cigarette drain. I give this much about the type of drainage used so that my discussion of the removal of the drains will be understood. While I think that the type of drains used is of only minor importance I do feel that two drains are better than one.

My chief concern however is in the removal of the drain. I have always removed the tube early either on the day after the operation or on the second day after the operation according to whim as I had no good reason for first-day removal except that it more nearly adhered to what I had been taught. I remove the cigarette drain two or three days after the removal of the tube drain generally two days. When there was profuse drainage, I

left the cigarette drain in until there was only a small patch of thin discharge, about two inches in diameter, on the dressing, but as a rule the discharge diminished to an area of this size by the second, or third, or fourth day. In a series of 951 cases, 229 were drained. Drains were removed as follows: first day twelve, second day 141, third day fifty-four, fourth day sixty-nine, fifth day twenty-one, sixth day twenty-one, seventh day five, more than seven days two. There was no record of the removal time in five cases. Only forty-nine drains were removed after the fourth day, while 276 drains were removed before the fifth day. It may be feared that the early removal of drains may lead to more secondary abscesses, but I have not found this to be the case.

I have noticed that muscles once separated by drains do not close tightly quickly after the removal of the drains. As a consequence, any retained secretions have been readily evacuated by turning the patient face down, or by a clamp, or the little finger inserted into the wound. Occasionally a secondary abscess has occurred in the pelvis. I have had this happen twenty-eight times. Fourteen times I drained the abscess by an incision into it through the rectum and the insertion of an umbrella tube drain for a few days with only a slight prolongation of convalescence and no disturbance of the abdominal wound. Fourteen times I drained the abscess abdominally either through the original wound or through a separate incision, but generally through the original wound. Furthermore, I have not had to trouble with sinuses as I did when I was an interne. There have been no fæcal fistulas. My mortality of 3.36 per cent compares favorably with those of men who remove drains much more gradually. A few figures showing some results of the late removal of drains may be interesting. Deaver³ reported 256 cases with fourteen cases of fæcal fistulas, in another series of one hundred cases, there were five fæcal fistulas, in a third series of 1,700 cases⁴ there were seventy-six fæcal fistulas with ten deaths or 14.7 per cent. Of this last group, 2.8 per cent required secondary operation with 16.6 per cent deaths.

Although fæcal fistulas are undesirable, they are only complications. The chief test for the early removal of drains is mortality, and here is what my records show. There were thirty-two deaths. Five had no drainage, but two of these, which were general peritonitis cases, should have had, at least, I felt that way after their deaths. Twenty-seven had drains as follows: tubes alone, three cases, one of which had three tubes, a second of which had two tubes, and the third of which had one tube. Tubes and cigarette drains, twenty cases: three of those had one tube and two cigarette drains, two had two tubes and a cigarette drain, and one had one each of the tube and cigarette drains in two separate cuts. There were only three cases which had cigarette drains only. One case died on the table from spinal anæsthesia as a tube and a cigarette drain were being inserted. This left twenty-six cases which lived for awhile with drains in. Of these twenty-six cases, seventeen died while drains were still present in the wound. Nine

cases died after the drains had been removed and the records of the causes of death in these cases are as follows. One died seven weeks after operation of multiple abscesses in the mesenteric glands. At the second operation the peritoneum was smooth and shiny and had thoroughly recovered from the primary peritonitis.

One died on the ninth day after operation from multiple emboli from thrombosed femoral vessels as shown by autopsy.

One died of starvation over five months after the operation because she wanted to die and refused to eat or to receive medical aid. She had been fully recovered for five months from general peritonitis and four months from a secondary subphrenic abscess which had been drained and from pleurisy with effusion which had been relieved by aspiration.

One died on the seventeenth day, two days after a secondary pelvic abscess had been opened abdominally. The cause of death in this case was acute intestinal obstruction of six hours duration. Death occurred two hours after the operation for the last condition.

One died a few hours after the drain had been removed on the fifth day. The temperature had been 103° and 104° throughout but the patient appeared to be in good condition and there was very little drainage. She was comfortable and the abdomen was soft. An enema was followed by collapse, distention and death.

One died just after the last drain was removed, but she was very near death at the time of the removal of the drain.

One died on the sixth day and the drain was out on the fourth day.

There were two cases in which I have no record of removal of the drain. Autopsy in one showed that the peritoneum had fully recovered from the inflammatory reaction. The patient evidently had died of exhaustion. He had been sick twelve days before the operation and entered the hospital with a temperature of 107° and died on the sixth day after operation after the temperature had shown a gradual decline to 100° .

The other case of which I have no record of the date of removal of the drain died on the thirteenth day while sitting up. He collapsed and died a few hours later. This death was probably caused by an embolism.

I have gone rather fully into the nine deaths in which drains had been removed so that others may decide if early removal of the drains had anything to do with their deaths. As for me I feel that the seventeen deaths with drains still present sufficiently counterbalance any argument which might be advanced to show that the early removal of the drains in three of the nine cases might have influenced the outcome. In the other six cases I feel that there can be no question about the fact that the lack of drains did not cause the deaths.

So long as my results have been no worse than they have been and with no fecal fistulas to report I feel justified in my conclusion that the early removal of drains is sound and that prolonged drainage is unnecessary as well as troublesome.

APPENDICOSTOMY IN CASES OF RUPTURED APPENDIX ASSOCIATED WITH DIFFUSE GENERAL PERITONITIS

BY ELI SHERMAN JONES, M D

OF HAMMOND, INDIANA

FROM THE DIVISION OF SURGICAL SERVICE OF ST MARGARET'S HOSPITAL

THE mortality in instances of acutely ruptured appendix accompanied by diffuse general peritonitis is extremely high under methods of treatment commonly employed. Such experienced surgeons as Lynch, Deaver, and Ashhurst report death rates as 57 per cent. The purpose of this paper is to consider the problems presented by this type of appendicitis and to describe a mode of management employed by the writer which has proved highly useful in his clinic and in the hands of other surgeons.

Surgeons commonly have observed that in acute abdominal lesions, particularly appendicitis, patients who develop fecal fistulæ accompanied by diffuse peritonitis usually recover provided there is not too much interference.

If fecal fistulæ do *not* develop, the convalescence is prolonged, stormy, and is complicated by great abdominal restlessness, severe pain, and marked prostration.

In 1924, in a patient who had an acutely ruptured appendix accompanied by diffuse general peritonitis, I treated the condition by appendicostomy. Recovery was rapid and uneventful, the patient was able to leave the hospital in fourteen days. There was no anxious period due to abdominal distention, septic intoxication, or severe pain. Since this successful termination, in which I first introduced appendicostomy to meet the condition, I have invariably employed appendicostomy in the management of acute appendicitis when complicated by rupture and peritonitis. A series of seventy-five patients, with a mortality of but 14 per cent, would appear to justify the procedure. It has been of considerable satisfaction to observe that Wilkie, of Edinburgh, to whom I described my procedure in 1926, and Gatch, of Indiana, with whom I discussed it in 1928, have had experiences comparable with my own. Wilson, of Emporia, employed a somewhat similar method and likewise reports excellent results.

It is not necessary to detail here all of the symptoms and the physical findings when an acutely ruptured appendix has become complicated by diffuse peritonitis. I wish to emphasize, however, a few points which I consider cardinal.

In this condition, one early observes marked abdominal distention and muscular rigidity. Frequently, there are vomiting, pain and restlessness. Severe toxæmia rapidly develops. The severity of the symptoms and signs is in direct proportion to the time-interval following perforation. While the leucocyte count and polymorphonuclear cell-ratio may be low at first, subse-

quent increase is rapid. Blood chlorides decrease and urea nitrogen increases in accordance with the degree of intestinal distention and the body fluid loss by vomiting. This phenomenon has been emphasized by Gatch and by Diagsted in experimentally produced and clinically occurring acute intestinal obstruction, ileus, or peritonitis.

In my series of patients the blood-chloride decrease ranges from 100 to 200 grams. As infection progresses and spreads, the intestine becomes progressively distended. With this increasing distention, the arterial blood supply to the intestine mechanically is interfered with. It has been shown that the duodenal and jejunal capillaries collapse when an intra-intestinal pressure of thirty-five to forty-five millimetres has been reached, the capillaries of the ileum withstand a considerably higher degree of pressure. The result of this closure of the arterial capillaries is ischaemia, and death of the gut on its anti-mesenteric border quickly follows. It is not unusual to have infective thrombosis occur, and then extensive infarction follows. In such circumstances, blood chlorides fall rapidly, and death ensues in a manner similar to that observed in acute intestinal obstruction.

To Wayne Babcock we are indebted for evidence showing that the normal peritoneum has a great capacity for absorbing large quantities of fluids. When peritonitis is present, however, this capacity for absorption is reduced about 95 per cent. An active defensive mechanism is then initiated, namely limitation to the absorption of toxins. If this defense mechanism is not disturbed, as by peristaltic activity, and by poor blood supply, and, if the source of infection can be removed, the peritoneum is in position to take care of the infection by which it is actually involved.

In order to obtain the most favorable results in the management of acutely ruptured appendicitis, complicated by peritonitis, it is necessary to appreciate the actual anatomical, physiological and chemical mechanism being exhibited, intra-abdominally, and, so far as possible, not to interfere with it. The operation of appendicostomy rationally meets conditions and in no way interferes with the series of protective measures instituted by nature.

Appendicostomy drains the caecum and the ascending colon directly. When the pressure is thus removed from the ileocecal valve, relaxation occurs. This is progressively facilitated as gas and contents of the small bowel move outward through the appendicostomy tube. It follows that the intestines are placed at rest, the demands for peristalsis are slight or nil, there is no distention, the blood supply tends to become normal as interference with capillary circulation is relieved. As peristaltic activity decreases the patient becomes comfortable and is able to secure needed rest. By the operation of appendicostomy obstructive adhesions rarely occur, provided there has not been rupture of the continuity of the endothelial cells from prolonged intestinal distention. In fact, the peritoneal exudate is, in itself, a protective force against the development of adhesions. Physiologists have demonstrated that the body absorbs about 65 per cent of its fluids and chlorides from the colon. Following appendicostomy the introduction of fluids and chlorides through the

appendicostomy tube prevents acute, systemic dehydration and rapid and serious chloride loss

My technic of appendicostomy in the management of acutely ruptured appendix with peritonitis is as follows

The abdomen is opened either by right rectus, or the muscle-separating technic of McBurney The appendix is identified and removed (This we



FIG 1—Appendix exposed, ready purse string suture at base and the introduction of rubber tube through stump

always do in order to get rid of the infective nidus) (Fig 1) Through the appendiceal stump a No 16 F catheter or rubber tube is inserted (Fig 2) Having first been passed through the omentum, a No 1 plain catgut suture is placed through both the appendix stump and the rubber tube and tied A purse-string suture of catgut or silk is next inserted around the appendiceal

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base the appendiceal stump and tube are inverted into the cæcum and the purse string tied (Fig 3 and insert)

The omentum is made to serve two purposes by the procedure , it separates the cæcum from the abdominal wound and prevents fecal leakage when the tube comes out The tube is then brought through a stab wound or through



FIG 2—Appendix removed, rubber tube secured in stump. Inset shows intracæcal protrusion of inverted stump and tube

the original incision (Fig 4.) The primary wound is then closed either with or without drainage. However, I generally prefer to insert a rubber-dam drain into the pelvis and one in the region of the hepatic flexure of the colon (Fig 5)

The wound is then closed in the usual manner. A non-absorbable suture

is inserted through the skin and the tube, to prevent the tube being pulled out by accident (Fig 5 and insert)

Post-operative Care—On being returned to bed the patient is immediately given 1,000 cubic centimetres warm normal saline hypodermoclysis. This may be repeated in six hours. The appendicostomy tube is left open for six hours,

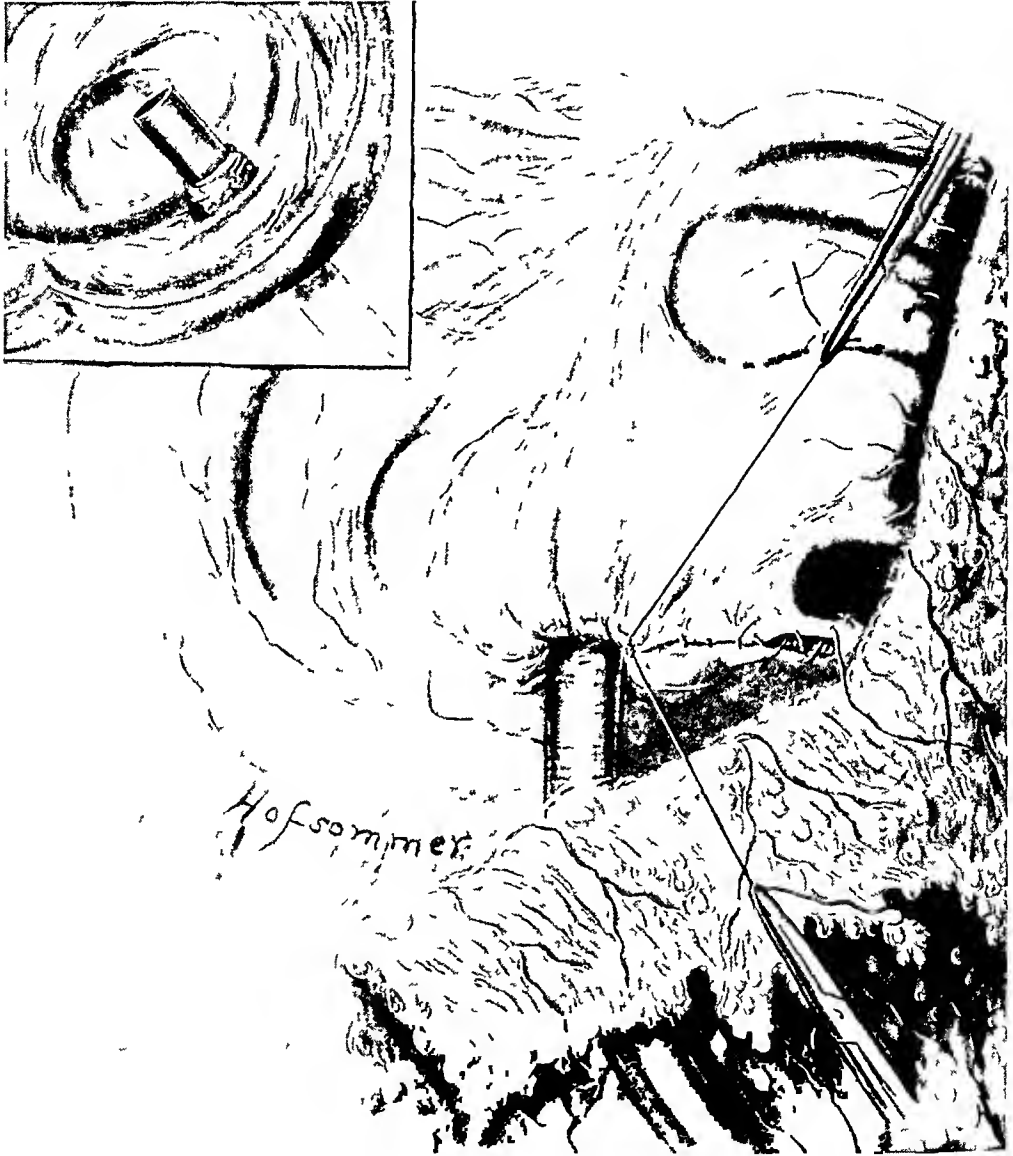


FIG 3—The inverted stump with tube as finally secured in place

at that time 200 to 300 cubic centimetres warm normal saline solution (depending on the size of the patient) are instilled into the cæcum through the appendicostomy tube. After instilling this solution, the tube is clamped for thirty minutes. The clamp then is removed and the tube remains open one and one-half hours. This procedure is repeated every two hours. The strength of the saline solution may be varied in accordance with the concentration

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of chloride in the blood. We have employed as high as 5 per cent saline solutions. However, if greater than 2 per cent, there is a tendency to cause diarrhoea. An adult patient can readily absorb as much as three litres of saline solution from the colon in twenty-four hours.

Without exception, nothing is given by mouth for forty-eight hours, this fasting period may be prolonged to seventy-two or ninety-six hours, according to the condition of the patient. In some cases we have waited five days before anything has been given *per os*. Fluids are absorbed from the colon in such large quantities that when given by way of the appendicostomy tube alone normal kidney function is possible, the patient's tongue and skin

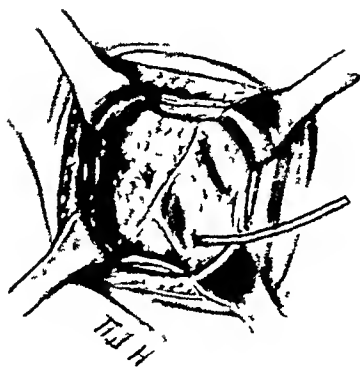


FIG 4—The rubber drain tube brought out through the primary incision on

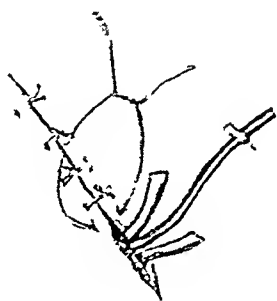


FIG 5—Drains placed around closed wound. Non absorbable suture through skin and tube shown in insert

remain moist, and he is comfortable. Should thirst become troublesome, a moist sponge to the lips, or the chewing of gum or wax (Smithies) gives relief. When fluids are started *per os*, we routinely give one dram of water every one or two hours. The quantity is increased accordingly as it is tolerated. Nutrient fluids also are administered as soon as it is found that water is well tolerated. Smithies' suggestion that raw milk be omitted is a valuable one. If milk is given it should be citrated (gr 1 sodium citrate to the oz), or parboiled, cooled and then flavored to suit the taste. Flavored cereal gruels carry high nutritional value, and usually are well borne. The vitamin demand is met by the employment of fruit juices, and the juices of tomato, sauerkraut meats, clams, etc.

The suture through the skin and tube is usually removed about the sixth or the seventh day, and the tube is permitted to come out spontaneously. We have never had a fecal fistula occur after the tube has been removed when appendicostomy is performed as above described.

Morphine is rarely needed except during the first forty-eight hours, when the patient is restless, or sleeps with difficulty. It is then administered only in small doses.

When shock is great and the peripheral circulation is markedly depressed, morphine, adrenalin, and other drugs often are ineffective, when given subcutaneously, because they are not readily absorbed. Under these circumstances, medication becomes efficacious if given intravenously (Smithies). The dosage by this route should be approximately one-half that commonly administered subcutaneously.

Glucose solution, milk, and other fluids are not introduced through the appendicostomy tube. They are not completely absorbed (probably the water only) and may do harm from acting as culture media for bacteria.

Our mortality rate in seventy consecutive cases has been 1.43 per cent. With other types of operation, and other methods of treatment, the reported mortality frequently has been as high as 57 per cent. Our average period of hospitalization has been eighteen days. The types of infection in our series have been *B. coli*, *Welchii*, and in a few instances, streptococci.

We have performed appendicostomies on many other types of appendicitis, in order to prevent anticipated post-operative distention.

The following CASE REPORTS are typical illustrations of the material with which we have to deal.

CASE I—J. F., male, laborer, aged twenty-six years. Admitted to the hospital February 2, 1924. Pain in the right side for two days, very sharp pain fifteen hours previous, then felt some better for a time. Abdomen distended and very rigid, tender, pulse, rapid, vomiting, temperature, 102° F., leucocyte count, 25,800, polymorphonuclears, 87 per cent.

Operation—McBurney's incision. Appendix ruptured about middle, general peritonitis, large amount of free fluid and no attempt at walling off or localization. Appendicostomy performed, a rubber dam drain to pelvis. Five days later (February 7) saline instillation through appendicostomy tube discontinued. February 9, 1924, tube came out. Patient was discharged February 16, (fourteen days after operation), returned to work four weeks from date of operation.

CASE II—J. H., male, aged thirty-six years. Admitted to the hospital July 17, 1925. First appendicitis attack, 1918, several attacks since. Forty-eight hours ago began with severe pain over entire abdomen, vomiting and prostration, pain became localized over right lower quadrant. Abdomen tense and very tender, tympanites marked, borborvgmus present. Leucocytes, 15,300, polymorphonuclears, 87 per cent, urine, albumin 1 plus. Blood chlorides, 300 mgm.

Operation—Ruptured appendix, general peritonitis, with no attempt at walling off. Appendicostomy with rubber dam drain to liver and pelvis. Distention down within twenty-four hours, temperature, 101°, on two occasions, eighteen and thirty-six hours after operation. Catheter came out on sixth day. Patient discharged August 4, 1925, eighteen days after admission.

CASE III—J. H., male, laborer, twenty-three years old. Entered hospital October

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15, 1928 Patient was told by two doctors five days ago he had a ruptured appendix, but refused to go to hospital Abdomen very tense, patient in shock and condition desperate Pulse, 140, temperature, 101°, leucocytes, 23,200, polymorphnuclears, 89 per cent

Operation—Large ruptured appendix, general peritonitis, with thick exudate No localized abscess could be demonstrated Appendicostomy, with drains to spleen, liver, left lower quadrant, and pelvis Patient improved and condition seemed very good October 21 at 9 00 A M the tube came out The abdomen immediately began to distend, patient became restless At 11 00 A M the tube was inserted through original opening, distention disappeared and patient immediately improved October 23, A M, the tube again came out, but I was not notified until 6 P M Patient's condition was bad Unable to re-insert the tube Distention was marked Jejunostomy performed The patient expired at 8 10 P M, October 23, 1928

CASE IV—E M, female, secretary, nineteen years old Admitted to hospital June 4, 1929 Severe dysmenorrhœa since puberty June 1, 1929, just finished menses, began with severe pain in right side accompanied by rigidity Her condition became much worse, and she was referred June 4, 1929 Abdomen distended, marked rigidity, and very tender, tympanites, "silent" abdomen Leucocytes, 28,800, polymorphonuclears, 89 per cent

Operation—There was a fecolith at the appendix base, size of a cherry stone, appendix ruptured at tip Pus was distributed over entire abdomen There was no attempt at walling off The gut was greatly distended and blanched, the blood-vessels being almost collapsed Appendicostomy performed, drain tubes to liver, left hypochondriac area and pelvis A very stormy convalescence, severe tonsillitis five days post-operative, with cervical adenitis and parotitis Patient became delirious, cyanotic, *etc*, and exodus was expected momentarily The appendicostomy tube came out June 13, 1929, condition became worse, the tube was re-inserted and kept in place two more weeks Culture showed streptococcus Patient was discharged August 13, 1929, has been perfectly well since

CASE V—D C, male, aged three years Admitted May 11, 1930 Mother had noticed for past week child has not felt well, appetite poor, restless and complained of pain in abdomen, past three days child would not eat, suddenly developed a severe pain in abdomen Abdomen greatly distended, extremely tender over entire abdomen, possibly more pronounced over right lower quadrant No palpable masses Stool has not contained any bloody mucus Rectal examination not made

Operation—May 11, 1930, muscle-separating incision Appendix gangrenous at distal end, perforated one inch from tip Free seropurulent fluid throughout entire abdomen No attempt made at localization Appendicostomy and Penrose drain to pelvis and rubber tube to liver Wound closed as in Fig 5 Hypodermoclysis 500 cubic centimetres six hours 150 cubic centimetres normal saline instilled through tube clamped one-half hour, open one and one-half hours This was repeated every two hours May 12, 1930, water one-half dram by mouth every two hours May 17, 1930, appendicostomy tube came out Patient discharged May 24, 1930, thirteen days after admission Has been perfectly well since

CASE VI—M H, female, aged seventy-seven years Admitted to hospital May 28, 1930 For three days pain in abdomen which was more or less localized Later it localized in lower right quadrant and has been accompanied by very severe nausea and vomiting

Operation—May 28, 1930, right rectus incision under novocaine An adherent, gangrenous, ruptured appendix removed Free fluid throughout entire abdomen, no localization Cultures demonstrated colon-bacillus infection Appendicostomy performed, rubber dam drains to liver and pelvis Wound closed in usual manner Hypodermoclysis, 1,000 cubic centimetres on retiring to bed 300 cubic centimetres normal

saline through tube after six hours, then every two hours June 2, 1930, five days after operation instillation through appendicostomy tube discontinued Tube came out June 4, 1930 Drainage quite profuse due to *B coli* infection, no post-operative distention, patient comfortable Temperature, 101° on admission, May 29, 99.8°, May 30, 99.6°, from then on temperature normal Patient discharged June 28, 1930, wound healed

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DIFFERENTIAL DIAGNOSIS OF ABDOMINAL MANIFESTATIONS OF ACUTE RHEUMATIC FEVER FROM ACUTE APPENDICITIS

BY PLIMPTON GUPTILL, M D
OF ROCHESTER, N Y

FROM THE DEPARTMENT OF SURGERY THE UNIVERSITY OF ROCHESTER SCHOOL OF MEDICINE
AND DENTISTRY ROCHESTER, N Y

VARIOUS abdominal manifestations of acute rheumatic fever have been recorded during the past three hundred years. In fact, in the seventeenth and eighteenth centuries obscure digestive disturbances were explained on a hypothetical rheumatic diastasis in the patient. Interest, however, in this symptom complex had largely subsided prior to 1880, when Lambin¹ expressed the possible localization of acute rheumatic fever anywhere in the gastro-intestinal tract with "predilection for the intestine."

Grant² reported in 1893, before the New York Medical Society, two cases of acute rheumatic fever in children with the onset by acute low abdominal pain, fever and localized abdominal tenderness and muscle resistance in the right lower quadrant. These abdominal manifestations subsided in three days with the appearance of polyarticular rheumatism. Two years later, Brazil³ recorded similar observations in two patients, onset of abdominal pain and localized tenderness in the right lower quadrant followed by typical polyarticular rheumatism. Both these authors comment on the possible association of rheumatism with appendiceal inflammation.

During the past thirty years, reports of isolated cases of rheumatic fever simulating appendicitis have appeared in the literature, and with the general acceptance of early intervention for acute appendicitis, many of these cases have been submitted to operation. With few exceptions, the extra-appendiceal nature of the pathology was noted immediately at operation with only a few cases of peritoneal irritation distant from the appendix recorded. The accumulation of pathological material during the past ten years has become sufficient to allow some analysis in changes of the appendix in reference to these phenomena.

There is evidence in occasional instances of a true peritonitis as supported by Wood and Eliason,⁴ who noted increase of clear abdominal fluid and signs of peritoneal irritation in the right upper quadrant although the appendix was normal. They collected several cases from the literature which were similar in nature. Recently Paul⁵ has reported a fatal case of acute rheumatic fever with localized diaphragmatic peritonitis of a true rheumatic nature although ante-mortem abdominal symptoms were absent. Poynton⁶ has also found, in fatal cases, peritonitis around the liver and spleen. However, the infrequency of true peritonitis is attested by Rolly, who found evidence of such in only two cases of 3,500 suffering from rheumatic fever.

M. Feuille⁶ finds rare but incontestable evidence that rheumatic fever may start with peritoneal inflammation.

The appendix, however, has not been observed to be involved even in the rare cases of peritonitis. At operation its appearance is normal with occasional histological changes consistent with earlier mild inflammation. Poynton has never found acute changes in the appendix in fatal cases of acute rheumatic fever. Tallerman⁷ observed two cases with signs and symptoms pointing to the right lower quadrant. The appendix was found to be normal at operation and joint symptoms appeared two days later, likewise Auvray⁸ noted a case with acute abdominal symptoms while at operation only a questionable chronic process in the appendix was found. Bernard¹⁰ also reported a case simulating appendicitis in symptomatology but at operation the appendix was found normal with oedema of the tissues of the latero-colic gutter. Articular symptoms were first noted four days after operation. Costedoat,¹¹ operating on a case of this nature, found nothing intra-abdominal whatever. He favors reference of pain from the pleura as an explanation of the symptoms rather than a true peritoneal irritation.

There are reported a certain number of cases with symptoms pointing earlier to acute inflammation in the right iliac fossa who, being held under observation because of "tachycardia and distant heart sounds,"¹² developed polyarticular symptoms the following day. Moffat¹³ likewise noted two unoperated cases whose abdominal symptoms cleared up spontaneously and completely with the appearance of articular symptoms. Auvray⁸ has further noted a case with a normal appendix at operation who had return of the abdominal symptoms three days post-operatively, at which time joint lesions appeared and the heart was definitely affected.

The similarity in onset of atypical forms of these diseases with the inadvisability of operation in acute rheumatic fever has awakened new interest in an endeavor to establish the differential diagnosis between acute suppuration of the appendix and pseudo-appendiceal syndromes of acute rheumatic fever.

A review of the 160 cases of acute rheumatic fever admitted to the Strong Memorial and Rochester Municipal Hospitals during the past six years reveals eight patients in whom a syndrome simulating acute appendicitis in some stage was present without proved inflammation of the appendix. Two cases with acute rheumatic fever developed acute suppurative appendicitis proved at operation. Exploration of the abdomen and appendectomy was performed on four of the other patients. The remaining four, although admitted to the surgical emergency with complaint of abdominal pain and tenderness, were held under observation because of lack of signs substantiating a diagnosis of acute appendicitis. These patients subsequently followed a typical course of acute rheumatic fever. The four cases submitted to operation were as follows:

CASE I—C. C., SMH No. 48,032, male, white, aged ten years, was admitted June 3, 1931, with complaint of abdominal pain. Four days before admission he had first noted

dull pain in the right side of the abdomen after jumping, the following day his throat became sore, and two days later the abdominal pain which had been constant became more severe and localized about the umbilicus. He was feverish, had nausea without vomiting. Castor oil and magnesia were administered without results. On the day of admission, the pain radiated toward the right inguinal ring.

The past history revealed uncomplicated measles at four years. One year ago routine examination showed normal findings. On one occasion, a sore throat with tender cervical glands was noted. Otherwise he was considered extremely healthy.

Family history revealed no familial diathesis or chronic diseases.

Physical examination showed a moderately ill, feverish boy. His temperature was 38.4°, the pulse 110 and respiration 20. The tonsils were large, injected, and there were tender cervical glands. The heart and lungs showed no abnormal signs. The abdomen was held in spasm in the right lower quadrant but his maximum spontaneous pain was at the umbilicus, this was exaggerated on inspiration. Tenderness to palpation was maximum at McBurney's point with pain on release only at this point. Percussion pain was localized in the right lower quadrant with pain referred from pressure in the left lower quadrant to the right. There was rectal tenderness bilaterally without induration. Leucocytic count, 13,300. Urine was negative. Throat culture was negative for K L.

Pre-operative diagnosis was acute appendicitis.

Appendectomy was performed immediately, no free abdominal fluid was present but old adhesions causing kinking in the middle with no sign of inflammation of the appendix.

Post-operative Course—Temperature was 39° to 40° C on the first two days, pulse 100-110, and respiration 20-30. Pain in the left ankle was noted on the first day post-operative, right ankle was swollen and tender the following day with pain in both knees. At this time systolic murmur was heard in precordium but no enlargement of the heart by percussion was found. The abdomen was soft, not distended, leucocytic count 6,000. The temperature descended by lysis to normal on the seventh day, and the pulse remained at 70 from that day on. The abdominal wound healed without suppuration. Salicylates were administered with satisfactory results.

Microscopical section of the appendix showed lymphoid hyperplasia with thickened submucosa and serosa. There was no acute inflammation present. Cross-section of a round worm was seen in the lumen. Culture from the right iliac fossa showed no growth. Convalescence was protracted but uneventful.

CASE II—F N, SMH No 31,024, male, aged fourteen years, white, was admitted January 3, 1930, with a complaint of abdominal pain.

Onset of present illness was three days before admission with sore throat, pain in legs and knees. The same day abdominal pain arising at the right costal margin anteriorly was noted, it soon localized in the right lower quadrant where it remained until admission. Frequent chilly sensations were present at onset with nausea but no vomiting. Cathartic was taken with watery evacuation and the day before admission, resistance of abdominal muscles was noted. The patient fell while coasting a week before admission, abrading the right groin and spraining the back. The symptoms of this injury, however, had largely subsided before onset of present complaints.

Past History—The patient had measles several years previously. T and A was performed at seven years of age but subsequently occasional sore throats with rhinitis. No previous history of muscle or joint pains, usual health reported as good.

Family history was not remarkable.

Physical examination showed an acutely ill patient. Temperature was 39° C, pulse was 120 and respiration 40. The face was flushed. Throat, lungs and heart were negative to clinical examination. Muscular resistance was found throughout the abdomen, with maximum tenderness in the right upper quadrant and at the umbilicus. There was no referred tenderness but definite rebound pain in the mid-right abdomen. Marked tenderness without induration on rectal examination. There was moderate spasm in the right lumbar muscles, tenderness in the right flank and over the spinous processes of

MANIFESTATIONS OF RHEUMATIC FEVER FROM APPENDICITIS

the ninth and tenth thoracic vertebra. The extremities were normal, leucocytic count was 30,650. Urine examination showed a trace of albumin, specific gravity 1.006 and negative otherwise.

Tentative diagnosis was acute appendicitis with perforation.

Operation was performed as an emergency. There was no free abdominal fluid. The peritoneum was normal on inspection. The appendix was free, normal in appearance. Intestines were normal. The liver was enlarged, its margin was at the umbilicus without peritonitis. The appendix was removed in the usual manner.

Post-operative Course—There was considerable improvement in vital signs directly after operation, but the following day abdominal pain recurred in the right upper quadrant. Rontgenogram of chest revealed peribronchial feathering, moderate dilatation of heart with prominence of pulmonary artery. On the fourth day post-operative, moderate abdominal distention was present, moderate pain in the right lower quadrant persisted but the wound was clean. The temperature was 37.5°, pulse 80, respiration 20 and leucocytic count 7,600. Convalescence remained unchanged until the twelfth post-operative day when pharyngeal redness was noted and definite cardiac signs were evident. Two days later, signs of diffuse bronchopneumonia were found. Further enlargement of the heart with double precordial murmurs developed. The course was rapidly downhill, the patient expired on the sixteenth post-operative day. Post-mortem examination was refused.

Microscopical section of the appendix showed lymphoid tissue to be normal, the submucosa thickened, slight dilatation of the serosal vessels. No acute inflammation was present. Blood cultures on two occasions showed no growth at five days. Throat culture was negative for diphtheria.

CASE III—R. P., SMH No. 50,952, female, aged thirty-one, married, white, was admitted on September 13, 1931, with the complaint of low abdominal pain, onset was twenty-four hours earlier with nausea and pain in the mid-right abdomen, distention and vomiting occurred soon after onset of abdominal pain. The stools were loose without diarrhoea for two days. Urinary frequency without burning since onset of present illness. The pain remained in the right mid-abdomen. There was no vaginal discharge. No chill or fever was noted.

Past History—The patient was one month prior to term in second pregnancy. Examination in pre-natal clinic two weeks before present illness revealed left border of cardiac dullness nine centimetres to the left of the midsternal line, action was regular, a rough systolic murmur in the precordium and soft systolic murmur over the pulmonic area were heard. The uterus was enlarged to seven months' pregnancy, foetus in L.O.A. position. Nine years previously she had had scarlet fever with subsequent acute articular symptoms in the left knee. This had been quiescent except for occasional joint pains during interim to date. T and A was performed at nine years of age, measles sixteen years ago. Otherwise she considered herself in excellent health.

Family History—Husband and one child well. No chronic or familial disease noted.

Physical examination revealed a well-developed and nourished woman. Temperature was 38° C, pulse 100 and respiration 20. There was no apparent change in the heart since earlier examination. There was moderate general abdominal distention without muscle resistance noted. Fundus was four fingers above the umbilicus. There was definite tenderness to the right of the fundus of the uterus with referred pain localized to the antero-lateral wall of the uterus on the right, which was more resistant to direct pressure than on the left. There was percussion pain over McBurney's point. There was no vaginal bleeding or discharge. Rectal examination revealed marked tenderness high on the right. Extremities were negative. Urine was negative. Leucocytic count, 11,400. Polymorphonuclears, 86 per cent. Wassermann was negative.

After four hours' observation, operation was performed with tentative diagnosis of acute appendicitis. The abdomen contained no free fluid or signs of inflammation.

Appendix was long, free, soft and contained three fecoliths. It was removed. The abdomen was closed without other procedure.

Post-operative Course—Fourteen hours after laparotomy there was spontaneous delivery of 2,200 Gm fetus followed by gastric dilatation, 1,000 cubic centimetres contents being recovered without relief of symptoms. Pulmonary oedema developed rapidly and the patient expired four hours later.

Post-mortem examination revealed acute mitral, aortic and myocardial rheumatic lesions, pulmonary oedema, acute splenic tumor, cloudy swelling of the kidneys, lymphoid hyperplasia of ileum, fibrinous pericarditis and pleurisy.

Microscopical section of the appendix revealed round-cell infiltration about the vessels of submucosa and muscularis. No acute inflammation was present. The placenta was normal on section.

CASE IV—M. D., SMH No. 38,839, female, aged nineteen years, white, single, was admitted on October 20, 1931, with the complaint of low abdominal pain. The onset was one day previous with five diarrhoea stools and low abdominal cramps. The patient had fainted three hours later. Examination at that time revealed tenderness just above the internal inguinal ring on the right, while the vital signs were normal. The leucocytic count was 7,400. The morning following admission, she was awakened by "stabbing pain" in the mid-right lower quadrant which was followed by normal bowel movement without relief. Intensity of pain was less during the day but remained localized in the mid-right lower quadrant. There was no nausea or vomiting. A normal catamenia had ended four days previous to onset of symptoms.

Past History—One year previous to present illness, a routine examination revealed calcified thoracic lymph-nodes, congenital shortening of the left leg $\frac{1}{2}$ inch with left lumbar scoliosis. This deformity was largely corrected by elevation under the left heel. Five months previous to present illness, herpes zoster of left lumbar region at the level of the second lumbar vertebra was present. Three months before present illness patient had had transitory dizziness and paræsthesias of hands, nausea for two or three days and palpitation. Tonsillectomy performed two months ago was followed by a temperature of 37.5° C for four days, pulse of 90-100 was present for several days after the operation. No cardiac changes were noted at any examination. In childhood patient had had the common diseases with occasional mild sore throat. Patient had not had scarlet fever or rheumatic fever. She had considered herself in good health until the past year.

Family history was negative for familial diatheses or chronic disease.

Physical examination showed a patient not acutely ill. Temperature was 37.5° C, pulse 88, respiration 20. The pharynx was negative, lungs were clear. Heart was not enlarged, action regular, soft systolic murmur at the apex was not transmitted. Blood-pressure was 110/60. Abdomen was symmetrical, moved on respiration, spasm of muscles was absent at first examination but one hour later it was noted in the upper and the lower right rectus muscle. Tenderness was found constantly about McBurney's point with pain on release of pressure. No referred or percussion pain was elicited. The right inguinal region was found to be normal. The extremities were normal. The urine was negative. Leucocytic count was 7,400.

The patient remained under observation for eight hours when operation was indicated because of continuation of symptoms. The tentative diagnosis was acute appendicitis. The abdomen contained no free fluid, the appendix appeared normal. A calcified gland in the mesentery was removed. Otherwise nothing abnormal was observed. Routine appendectomy was performed.

Post-operative course was not unusual for the first ten days. The wound healed by primary union. Twelve days post-operative she complained of pain in the ankles and knees. At this time a history of subcutaneous nodules of the insteps, three months earlier, for two weeks, was elicited. There was now moderately elevated temperature, definite increase in cardiac signs was noted. She responded to salicylate therapy.

Microscopical Section—Appendix showed the lymphoid tissue to be abundant. No acute inflammatory reaction was present. The lymph-node was typically tuberculous in nature with fibrotic lymphoid tissue containing plasma cells at the periphery of the gland.

These cases serve to illustrate the difficulties encountered in differentiating appendiceal inflammation from the pseudo-appendiceal symptoms of rheumatism. In each case except the first, decision in favor of operation was reached only after careful differential diagnosis. Acute rheumatic fever however had not been considered as an etiological factor of the abdominal symptoms. Four other cases not markedly dissimilar to these in history and abdominal findings, were held under observation because of evidence of active cardiac lesion. These latter patients responded to salicylate treatment without subsequent evidence of appendicitis.

A review of the microscopical sections obtained from the four specimens of appendix removed failed to reveal Aschoff nodules or perivascular changes similar to those noted recently in the lungs by Frazer¹⁴ and other parts of the body by Meltzer¹⁵. Recently, studies by Kling¹⁶ show that these, however may occur only later in the disease, the early reaction to the toxæmia being extranuclear swelling of the fibroblasts. It is evident in view of the negative findings in the appendix that the clinician must reconsider the means of diagnosis in the hope that some sign will be developed to differentiate these two diseases. At present this is not available, but observation in the sequence of symptoms in rheumatism reveals them not to follow the usual typical findings of appendicitis.

There is little to be gained from analysis of abdominal pain. This is typical in proved appendicitis in less than 75 per cent of the cases and pain may be typical for appendicitis without a true inflammatory process. Brennen¹⁷ has commented on the characteristic abdominal pain much like appendiceal colic associated with acute throat infections in children which is not often due to true appendiceal inflammation.

Vomiting, however, is markedly more constant in true appendicitis, being 90 per cent positive in children or adolescents and not observed to be absent when diarrhoea occurs spontaneously at the onset of appendicitis¹⁸. However, in acute rheumatic fever with symptoms pointing to the right lower quadrant, the infrequency of vomiting is attested by Costedoat and others. In our four cases, it occurred but once and that in the case of an eight months' pregnancy.

The history of definite sore throat, coincident or directly preceding the onset of acute rheumatic fever, is often elicited, 30 to 40 per cent. And although Evans has shown such to occur occasionally before appendicitis, it is uncommon and is usually one to two weeks earlier. The abdominal pain following epidemic throat infections is characteristically referred to the umbilicus when not appendiceal in origin. Abdominal signs are variable as rheumatic manifestations. Muscle resistance when present is usually voluntary and is entirely inconsistent with the amount of tenderness which is more often than not marked and diffuse. All four of our cases had diffuse right-

sided abdominal tenderness but only one had true spasm, localized in the right lower quadrant. Different points of maximum tenderness may be recorded by two observers or may shift between observations by the same man in acute rheumatic fever. I cannot account for the rectal tenderness recorded in our cases. I have always considered it an important factor in doubtful cases of appendicitis and believe in these cases here it was an appreciable factor in deciding for operation. On more than one occasion, œdema of the pro-peritoneal tissue has been recorded during laparotomy in rheumatic cases without other evidence of peritonitis. There is no evidence to suppose that rectal tenderness is present, however, on this basis.

Certain manifestations of suppurative appendicitis when present are of a deciding factor. Britton reports a constant finding of contracture of the right cremaster on pressure over the appendix only when this organ is gangrenous. Jezierski¹⁹ has noted myosis of the left eye from pressure in the ileocecal region in appendicitis but not in those cases simulating it. Livingston²⁰ describes a definite triangle in the right lower quadrant of hypersensitiveness of the tissues of the abdominal wall to pinching. He considers this highly constant, 86 per cent, in acute appendicitis prior to perforation. Increased sensitiveness outside this triangle has not been observed by him due to acute appendicitis. In the absence of any of these diagnostic signs, appendicitis cannot be excluded but will be considered less likely.

Although elevation of leucocytic count is a relatively constant finding in both these diseases, Yaguda²¹ reports 671 appendectomies with Schilling count showing constant increase in the percentage of immature polymorphonuclear leucocytes, consistent with the degree of suppuration. This is an important observation as regards appendicitis alone but when correlated with the observation of Perry²² that in rheumatic disease there is no "shift to the left or right," though the count may be 15,000 or more, is highly significant. The importance of the Schilling count in this differential diagnosis is attested by

A girl, eighteen years of age, who was admitted to the Strong Memorial Hospital (No. 39,630) November 19, 1932, because of a dull pain in the right lower quadrant of the abdomen. The onset of pain was sudden, five days previously, while on her way to school. The pain was sharp, extended across the abdomen below the umbilicus without radiation to the back, perineum or lower extremities. Nausea occurred shortly after the onset and had been present intermittently until admission. There was no vomiting. The pain was less severe the day after onset although it had kept the patient awake that night and those following. A whitish vaginal discharge had been present throughout the present illness. The patient had taken a small dose of magnesium sulphate the first day of her illness. She had had regular bowel movements. There had been no fever or chills. The day of admission the pain had become more intense and was limited to the right lower quadrant of the abdomen. Last menstrual period ended two weeks before present illness.

The past history revealed that the patient had been admitted to this hospital two years previously because of pain in the right lower quadrant of the abdomen of two weeks' duration. Nausea or vomiting had not been present. She had had previous mild attacks for four years, often associated with onset of menses which were irregular.

There was slight vaginal discharge most of the time, worse when the patient was fatigued. On this admission temperature was 37.5°C , pulse 88 and respiration 20. There was slight tenderness at McBurney's point and voluntary muscle resistance in the right lower abdomen. The vagina was small with a firm, fibrous band in the lower rectovaginal septum. There was no tenderness or abnormal masses in the pelvis. The leucocyte count of the blood was 9,450. A definite diagnosis was not made, the attacks of low abdominal pain being considered dysmenorrheal in origin. Symptomatic treatment for this condition was directed by the gynecological service.

During the interim from the first to second admission, the patient had been nervous, apprehensive, with unintentional jerking of the hands and legs which was aggravated by emotional strain. She had had repeated upper respiratory infection during the winter months, although the tonsils had been removed eight years previously. She had had transient, infrequent attacks of headache and vertigo. Ophthalmic examination and glasses failed to relieve these attacks. She had not had any muscle or joint pain. Otherwise than as stated she had been healthy.

Family history showed nothing remarkable.

Examination on admission showed temperature 37.2°C , pulse 88 and respiration 22. She was well developed and nourished, not acutely ill. There were purposeless movements of the legs and arms with occasional jerky movements of the entire body. She had marked acne vulgaris of the face with hypertrichosis. The tongue was furred, there was lymphoid hyperplasia in the pharynx but no acute inflammation. Expansion of the chest was equal on both sides, the lungs showed no pathology to routine examination. The heart dullness to percussion was within normal limits, apical rate was 150 per minute with sinus arrhythmia. The first muscle sound was markedly accentuated with systolic murmur at the apex not transmitted, second muscle sound was snapping in character, second pulmonic sound was greater than aortic. The radial pulse was rapid and small in quality. Blood-pressure was 105/70 millimetres mercury. The abdomen showed increased muscle resistance throughout the right lower quadrant. There was marked pain on deep pressure in the mid-right lower quadrant with marked pain on release of pressure and subsequent nausea. No masses were felt. Pressure in the left lower or either upper abdominal quadrants caused no pain. Pelvic examination showed organs in normal position without masses or tenderness. Extremities were well developed without paralysis, reflexes were bilaterally equal and active.

Laboratory tests showed urine—specific gravity 1.010, very slight trace albumin, otherwise negative. Leucocyte count of blood was 13,700, 84 per cent of which were polymorphonuclear neutrophils in chamber count. Schilling differential count showed no juvenile cells, there were four stab cells and eighty-four segmented neutrophils in 100 cells counted.

A tentative diagnosis of chorea with question of acute appendicitis was made. Sodium bromide one Gm and atropine sulphate 0.006 Gm were given and the patient admitted for observation.

Subsequent examinations showed persistent tenderness without spasm in the mid-right lower quadrant. Repeated leucocyte count of the blood was 13,700 without change in constituents from the earlier count. The character or intensity of abdominal pain was unchanged by drugs administered.

Because of the localization and persistence of symptoms, laparotomy was performed ten hours after admission. The appendix was found anchored to the posterior abdominal wall in the middle by a thin fibrinous band causing angulation but not constriction at this point. There were no signs of inflammation in the appendix or elsewhere in the abdomen. The uterus was small, retroverted and slightly tipped to the right. The right ovary was larger than the left, but not cystic. Appendectomy was performed.

Microscopical sections of the appendix were interpreted as normal for this organ, there being only slight increase in vascularity of the subserosal vessels.

Convalescence from operation was not remarkable, purposeless movements were more pronounced, being unaffected by nervous force to the patient's tolerance. The leucocyte count of the blood three weeks after operation was 12,500, polymorphonuclears being 66 per cent. One month after admission there was decrease in choreiform movements with complete cessation one week later at which time the patient was discharged.

Summary—Certain patients suffering from acute rheumatic fever present abdominal signs and symptoms similar to acute appendicitis. Four cases of this nature, proved to be not appendicitis at operation, are reported. From these patients it is observed that the symptoms of acute rheumatic fever, although suggestive, are not identical with any of the usual types of appendiceal inflammation. The symptom for which medical attention is sought is mostly abdominal pain. The onset is in the mid- or lower abdomen, quite often severe or lancinating in character. Nausea occurs in the first few hours but vomiting, even in children, rarely is present throughout the illness. Spontaneous diarrhoea is occasionally present the first day or two of the abdominal pain. There is in the immediate or past history evidence of rheumatic fever. This type of patient on examination is often restless and apprehensive, complaining of increased abdominal pain on jarring or forced inspiration. Occasionally there is marked increase in the pulse rate with or without clinical evidence of early cardiac involvement. Abdominal tenderness is unquestionable, often present in both lower quadrants and at the umbilicus with the maximum about the base of the caecum. Muscle spasm is absent, the voluntary resistance occasionally met with being noticeably less extensive in area than the tenderness. Hypersensitiveness of the abdominal wall in the right lower quadrant has not been observed in acute rheumatic fever. Rectal tenderness is present in a high percentage of cases. The leucocyte count of the blood is increased without increase in juvenile granular cells.³⁷

The essential points in differential diagnosis are lower incidence of vomiting, lack of spasm in the presence of diffuse and marked abdominal tenderness and normal Schilling differential with persistent leucocytosis in the case of acute rheumatic fever with onset by abdominal manifestations whereas in acute appendicitis, vomiting, especially before the age of twenty, is present in 90 per cent of cases, spasm corresponds favorably in extent with the abdominal tenderness and the Schilling differential shows an increase in juvenile cells even when there is only slight increase in the number of circulating cells. In case, however, reasonable doubt persists after ten hours' observation, operation is advised as involving less risk in acute rheumatic fever than further delay in acute appendicitis.

CONCLUSIONS

(1) Certain cases of acute rheumatic fever manifest abdominal symptoms suggestive of acute appendicitis.

(2) At operation no causes for the symptoms in the right lower quadrant are found.

MANIFESTATIONS OF RHEUMATIC FEVER FROM APPENDICITIS

(3) There is no gross or microscopical evidence yet that rheumatic involvement of the appendix occurs

(4) Vomiting abdominal spasm and increase in Schilling count of the blood are singly and collectively relatively constant findings in acute appendicitis

(5) Vomiting, spasm and increase in Schilling count of the blood are infrequent individually in acute rheumatic fever beginning with abdominal pain and tenderness and have not been observed to occur collectively in such cases

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THE DIAGNOSIS OF PHLEBITIS IN VARICOSE VEINS WITH THE AID OF THE SEDIMENTATION RATE *

BY HYMAN BIEGELEISEN, M D
OF NEW YORK, N Y

FROM THE VARICOSE VEIN CLINIC OF THE GERMAN POLYCLINIC

IN SEARCHING the text-books and literature for information about phlebitis, one is impressed by the lack of interest shown regarding this condition. Not only is there an actual dearth of knowledge, but phlebitis is mentioned throughout as an unvarying entity without any attempt being made to classify its forms. One is therefore forced to formulate his own conception of phlebitis in order to intelligently consider the subject. The viewpoint presented here was reached after months of work at the Varicose Vein Clinic of the German Polyclinic spent in trying to establish a practical method of diagnosis for this troublesome condition.

At the outset it is important to point out the difference between phlebitis occurring in the normal vein and that condition in the dilated varicose vein. The ordinary phlebitic inflammation is usually readily recognized by the presence of a hard thrombotic process, plus the familiar signs of any inflammation, namely, redness, tenderness and heat. This diagnostic rule, however, does not suffice for the phlebitis of varicose veins.

The reason for the difference in clinical appearances is due to the fact that the varicose vein is the seat of a stagnant reverse flow¹ and its wall heals with great difficulty or not at all. On account of the abnormal metabolic conditions present, there is a great tendency for the inflammatory processes to remain chronic or latent for long periods of time. Furthermore, the tissues which are bathed by this vicious circulation tend to become infected for long periods, and so act as a focus for the continuation of phlebitic processes.

The stagnant blood pool present in varicosed extremities offers an ideal culture medium for bacteria that may be fed into the circulation from any focus in the body. Thus, an acute phlebitis may arise spontaneously without apparent cause or following some trivial injury. Another cause of an existing phlebitis is that it may be present as a "hangover" from a post-partum or post-operative phlebitic infection. It is a common experience for one who treats this condition to find evidences of phlebitis existing years after an initial post-partum "milk-leg" infection. In addition, the various toxins that cause phlebitis in normal veins may, of course, operate with greater force in these less resistant tissues.

It is necessary to call attention to various types of phlebitic inflammation occurring in dilated veins. The very acute types are readily recognized be-

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cause of their resemblance to phlebitis elsewhere. However, the milder phlebitides often pass unrecognized and are responsible for many complications that arise in the injection treatment of today.

These milder inflammatory processes sometimes have suspicious characteristics. Thus, the patient may complain of pain and examination may disclose tender thromboses which show a definite hyperthermia. However, in other cases the signs of infection may be very slight, so that the operator is often in doubt, especially since many normal varicose extremities are tender and warm to the touch. In addition, it is possible to get so-called latent infections which have practically no physical signs that would help in the diagnosis. All these infected veins must be differentiated from the uninfected, relatively normal, dilated fibrous vein. It can thus be seen that cases of phlebitis may present varying degrees of inflammation starting from the typical acute form and extending without any dividing line down to the slumbering infections.

That this is not mere conjecture has been proven often to the distress of the operator and the patient by the occurrence of acute flare-ups in supposedly normal veins. These flare-ups come after an incubation period of two to ten days. This leads one to suspect that peacefully slumbering bacteria have been encouraged to grow and make their presence felt after a sufficient lapse of time. Formerly, these reactions were very puzzling and were attributed to chemical irritation. However, the presence of the incubation period and the spreading nature of the process stamps them in my mind as inflammatory phenomena.

The work of DeTakats² amply bears out this idea. He excised the saphenous vein routinely in a series of cases and planted the segments in a nutrient medium. He found that 50 per cent of apparently normal veins harbored bacteria. These bacteria grew slowly and only showed up in culture after three to ten days. This fact falls in line with the clinical evidences of slumbering infection mentioned above.

The importance of recognizing phlebitis in any form cannot be overestimated. The few cases of fatal embolic phenomena that were once reported are now readily understood. The explanation is that in these cases irritating solutions activated existing infections to cause the formation of a friable infected clot, rather than the aseptic firm thrombosis which one seeks. In addition to these disastrous happenings, many occurrences of milder activation have taken place to the great discomfort of the patient. If the danger of arousing phlebotic processes in varicose vein therapy could be eliminated, one would have a more nearly perfect form of therapy.

The importance of diagnosing this condition is therefore apparent, but up to the present time there has been no satisfactory method available, reliance having been placed on clinical signs. Clinical evidence, however, will not suffice for diagnosis, so at the German Polyclinic for the past year the method described below has been in use.

The blood sedimentation rate has been employed to estimate the degree

of inflammation that is present. Since this test is not specific in phlebitis, other conditions must be eliminated in order to properly evaluate its significance. In other words, a positive test indicates the presence of phlebitis only in the absence of any other infection. However, with proper exclusion of other factors, it gives us information of great value.

It must also be pointed out that the test is roughly a quantitative one in that it estimates the degree of inflammation present. Thus, one is able to form a conception as to the amount of activity that is present. This is a good guide for determining the type of treatment to be used.

The test is made in the usual manner by mixing 0.2 cubic centimetre of 5 per cent sodium citrate with 0.8 cubic centimetre of whole blood in a 1 cubic centimetre graduated sedimentation tube, and the time noted during which the column falls to the 18 millimetre mark. A time interval below one hour is indicative of fairly active inflammation. Rates of two hours or more indicate the probable absence of any activity. Table I illustrates the use of this method in fifty cases.

In analyzing Table I, one must be careful to evaluate all the factors present in each case, so as not to be drawn into false conclusions. In a few instances the test apparently falls down, but here closer scrutiny reveals factors that have not been fully appreciated. One is impressed in this study by the ease with which complicating infections are discovered and ruled out simply by thorough routine examination.

The cases enumerated are purposely diversified in type so that a number of influences can be studied in their relationship to the sedimentation rate of phlebitis. The inclusion of the hæmoglobin percentage was made in order to rule out slow sedimentation rates due to anæmia.

The first three cases are ones in which phlebitis was proven present. In the first case, it was questionably present, but the sedimentation time of twenty-five minutes, in addition to the physical signs, made the probable diagnosis a definite one. The second case was a definite phlebitis, and here the sedimentation time of twenty minutes confirmed the diagnosis. Case No. 3 gave a history of phlebitis fifteen years ago, but the question of the existence of a latent infection could not be answered clinically. It was decided to treat this case and a severe migrating phlebitis occurred following the injection of 2 cubic centimetres quinine. This was undoubtedly due to the lighting up of a latent phlebitis. The sedimentation rate of twenty minutes should have been a warning not to inject this case.

The fourth patient gave a rather rapid rate of forty-four minutes, but subsequent treatment proved uneventful. The presence of a severe widespread lymphangitis was the probable cause of this rapid rate, since there was no phlebitis actually present. Case No. 6 had tender thrombosed segments, but no phlebitis, as shown by the sedimentation time of one hour and fourteen minutes. Without the sedimentation test as a guide, this case would have been left untreated on account of the suspicion aroused by clinical signs.

TABLE I

Case	Phlebitis	Other Inflammatory Conditions	Ulcer	(Taillqvist) Hgb	Remarks	Sed Time Hrs
1	Questionably present	N	Pres —1 yr	90%		0 25/60
2	Pres —10 days, 1st attack 2 yrs ago for 2 mos	N	N	85%		0 20/60
3	15 yrs ago, both legs	N	N	80%	Got severe migrating phlebitis—rt leg after 2 cc quinine	0 20/60
4	Questionably present	N	5 ulcers pres —3 yrs	80%	Ulcer on bed of hard lymphangitic induration	0 44/60
5	N	N	N	75%	Simple goitre for 7 yrs —B M R (—5%)	1 14/60
6	N	Foot infection recently healed Has tender thrombosed segments	N	80%	Treatment without untoward result	1 14/60
7	N		Pres —3 mos	85%		3 25/60
8	N	N	2 ulcers pres —2 mos	80%	Large hernia	2 20/60
9	Pres —rt leg for 1 yr, redness, tenderness	N	N	70%	Did not inject	0 48/60
10	N	N	N	80%		2 55/60
11	N	N	N	75%		2 00/60
12	N	N	N	90%		2 42/60
13	N	Rt sacro-iliac arthritis	N	90%		0 30/60
14	Attack 2 wks ago, 1st attack June, 1932	N	N	85%	Painful phleb pres —patient was cautiously treated	1 20/60
15	N	N	N	85%		1 22/60
16	7 yrs ago on history	N	Pres on lt ext malleolus	85%		2 00/60
17	Active phleb 6 mos ago, 1st attack 2 yrs ago	N	N	80%	Got severe reaction in lt leg after 2 cc quin	0 50/60
18	N	Sacro iliac arthritis	N	80%		0 37/60
19	Questionably pres —P P phleb lt leg 20 yrs ago	N	N	85%	Treated successfully although tender lumps were pres	1 00/60

PHLEBITIS IN VARICOSE VEINS

20	N	Pain in knees	Healed	90%	Treated	1 2/60
21	12 yrs ago	Pain in knees	Healed	85%	Expiured Jan, 1933—intra-abdominal	1 25/60
22	6 mos ago	Pain in knees	Present	80%	condit—untreated	2 31/60
23	Questionable	N	1/2 yr ago	80%	Tender, hard indurated area pres	4 10/60
24	Indefinite history	N	N	95%		1 42/60
25	Active phlebitis attack 8 yrs ago	N	N	90%		0 50/60
26	Tender vein in lt leg	Arthritis at ankle	N	90%	Treated	1 1/60
27	N	N	N	75%	16 injections	1 30/60
28	N	N	N	80%	6 injections	1 20/60
29	N	N	N	90%	6 injections	2 26/60
30	N	N	N	90%		2 00/60
31	N	N	N	90%		3 49/60
32	N	N	N	80%	Clamps on walk Watch for T A O	1 1/60
33	Rt popliteal area tender 3 yrs ago	Fistula in ano 3 yrs ago	N	80%	Arteriosclerosis pres, chronic nephritis	1 6/60
34	3 yrs ago	N	N	90%		2 25/60
35	N	N	N	80%		3 28/60
36	N	N	N	90%		2 32/60
37	N	N	N	90%		5 30/60
38	N	N	N	95%		4 12/60
39	N	N	N	100%	Trace albumin pres—10 inj	0 50/60
40	Attack 1 yr ago	N	N	100%	2 cc Na mori gave chemical migration phleb	1 13/60
41	N	Chl hyp arthritis at knee	N	90%	Trace of sugar	1 5/60
42	N	Chl arthritis lt knee	N	95%	Chl nephritis plus-minus Wass	1 18/60
43	N	N	Pres—(lucic?)	100%	27 injections	1 15/60
44	N	N	N	100%	24 injections for capillaries	1 20/60
45	N	N	N	100%	Migrating charac of tender lumps caused confusion	2 25/60
46	Skin lesion or phleb?	N	N	90%	Thrombosed segments sl tender quest activity	3 00/60
47	Questionably present	N	N	90%		2 20/60
48	N	N	N	100%		2 20/60
49	N	N	N	90%		4 25/60
50	N	N	N	90%		2 7/60

The eighth case had two ulcers, but the sedimentation time was normal. This last finding proved constant throughout the series. Varicose ulcers do not influence the rate of sedimentation of the blood-cells.

The above illustrations are given in order to explain how the table is to be interpreted. Invariably, it was found that complicating inflammatory conditions, especially the arthritides, influenced the sedimentation rate markedly. In other words, a rapid sedimentation time in the presence of arthritis is of no value in the diagnosis of phlebitis.

On the other hand, a number of non-inflammatory complications are to be noted in the series which did not affect the sedimentation time. These include albuminuria, traces of sugar, hernia and simple goitre. The hæmo-



FIG 1—Illustrating the difficulty of diagnosing phlebitis by clinical signs. This case had thromboses, hyperthermia and tenderness but no phlebitis. Treatment uneventful.



FIG 2—A case of varicose veins with ulcer that was apparently normal. However the sedimentation rate was below an hour and the injection of quinine caused a migrating phlebotic reaction.

globin percentages also had very little bearing on the rates, since they ranged between 70 per cent and 100 per cent in the whole series.

It should be noted that every case presenting a definite active phlebitis gave a definite rapid sedimentation time. It should also be noted that in a number of cases where the diagnosis of phlebitis was in doubt, the sedimentation time settled the question for us. Furthermore, in those cases where the warning of a latent phlebitis, as evidenced by a rapid sedimentation time, was disregarded, migrating reactions were secured.

Another point of interest in connection with the technic is brought out by those cases which had received injection therapy prior to the test. In some of these, a little more rapid rate than normal was secured. This means that

the chemical phlebitis, caused by sclerosive injections, influenced the sedimentation rate. Therefore, to secure uniform results, one should make this test before beginning treatment.

Despite careful interpretation there still remain a few contradictory results which are unexplainable on any basis. This does not to my mind destroy the value of the test since it must be understood that any laboratory procedure is open to various errors. This is especially true in the case of the sedimentation test because the explanation of the settling phenomenon is as yet unknown. The delicate physical-chemical action which operates to cause a more or less rapid settling of red blood-cells can be conceivably upset by trifling changes in technic. However, with increasing experience there is no doubt but that this test will grow in usefulness.

CONCLUSIONS

- (1) Phlebitis in the varicose vein is peculiar in that chronicity and latency of infection are the rule.
- (2) Many apparently normal varicosed extremities harbor latent infections that may be aroused by chemical irritation.
- (3) Clinical evidence alone will not always suffice for the diagnosis of phlebitis in varicose veins.
- (4) The blood sedimentation time has been employed to estimate the degree of inflammation that is present.
- (5) A sedimentation time under one hour in the absence of other inflammatory conditions points to the presence of phlebitis.
- (6) The presence of clinical signs, plus a rapid sedimentation rate, is definite evidence of phlebitis, in the absence of complicating infections.
- (7) A sedimentation rate over two hours probably indicates the absence of phlebitis.
- (8) Varicose ulcers do not influence the sedimentation time.
- (9) This test should be a routine procedure before beginning the treatment of any patient exhibiting varicose veins.

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SCLEROSING INJECTIONS IN SURGERY

BY VICTOR CARABBA, M D ¹

OF NEW YORK, N Y

FROM THE THIRD SURGICAL DIVISION OF BELLEVUE HOSPITAL

IN MAY, 1931, Porritt¹ wrote on the injection treatment of hydrocele, varicocele, bursæ and nevi using 5 per cent sodium morrhuate. Since 1929, we have been using an injection method in many surgical conditions. The excellent results have prompted us to present this preliminary article in the hope that other men will report their experiences with this method or devise a still better technic.

The following are the conditions in which the treatment has been applied (1) *Bursitis*—Elbow, knee, etc., especially pre-patellar and olecranon bursitis (2) *Cysts*—Mucous cysts of mouth, thyroglossal, branchial, sebaceous, ranula (3) *Sinuses*—Thyroglossal, branchial, dermoid, and other surgical sinus, non-tuberculous, syphilitic or malignant (4) *Hemangiomas*—Tongue, face, scalp (5) *Ganglion* (6) *External Hemorrhoids* (7) *Vaginal Varices*

Sclerosing Solution Used—Many solutions can be devised having the sclerosing effect. We have chosen the following formula which consists of Phenol, 45 cubic centimetres, borax, 16 grams, acid salicylic, 16 grams, glycerin, 120 cubic centimetres, spirits of camphor—enough to make 240 cubic centimetres. The mixture is easily prepared, clear, never forms a sediment and readily flows through a small-calibre needle. The solution is slightly yellowish in color. If not kept in a dark colored bottle a reddish-brown color develops. This no doubt is due to the carbolic content. No special precaution is necessary to keep the solution sterile owing to the high phenol content. A bottle of the solution exposed to the air for some time proved to be sterile on culture. The best method of handling the solution is in a small bottle dark in color, with a rubber stopper through which a needle can be readily introduced. This allows the use of the same technic as in handling sera.

Anæsthesia—Two per cent novocaine solution is the local anæsthesia of choice.

Equipment—Several sized syringes and needles for aspiration and injection are necessary, the size depending on the amount of fluid to be aspirated and the viscosity of the fluid exudate or secretion. The injection of the sclerosing solution is usually made with a two-cubic-centimetre Luer syringe and 25-gauge needle or the injection is made through the same needle that was used for aspiration.

Bursitis—In the treatment of bursæ, especially those not communicating

* Read before the New York University Medical Society, November 7, 1932

with a joint notably the olecranon and pre-patellar bursæ, the fluid is aspirated and from one cubic centimetre to three cubic centimetres of the solution is injected through the same needle, the needle is then removed and a compression strapping applied. As a rule, one injection suffices. If there is any slight recurrence of effusion, it is readily absorbed within two weeks without reaspiration or reinjecting.

If at the end of two weeks the effusion has recurred to a moderate extent a second aspiration and injection may be necessary. Occasionally three aspirations and three injections have been required. The failure to attain satisfactory results has been found to be due to concretions (fibrinous or otherwise) in the bursæ. In cases therefore which are stubborn to treatment it is necessary to make a small incision into the bursa, to evacuate the solid contents and effusion and the reinjection of the sclerosing solutions.

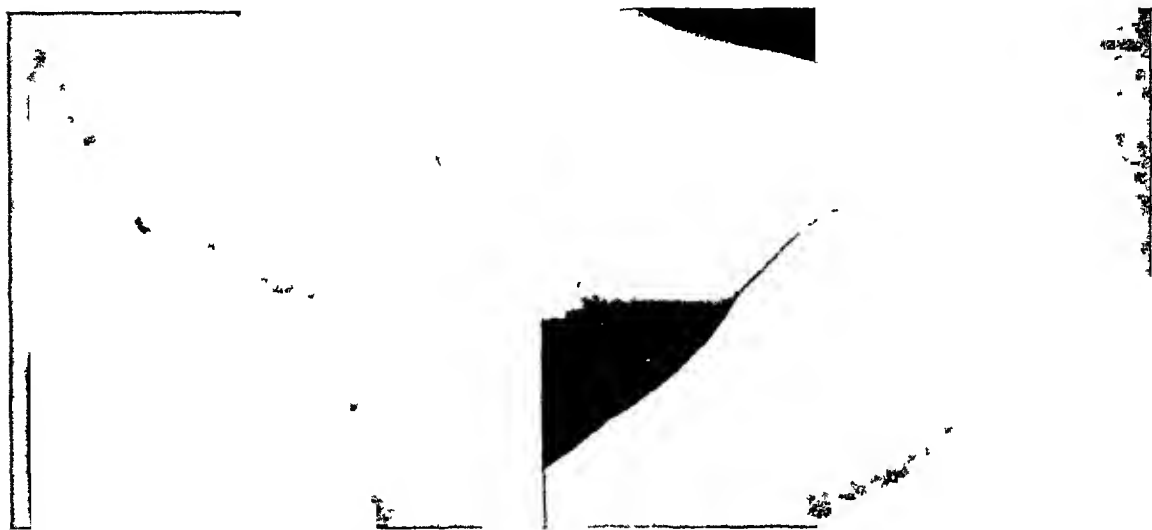


FIG 1 —Bursitis about left elbow joint of one year's duration

FIG 2 —Complete cure with no recurrence after 2 years' follow up

Porritt¹ makes special emphasis that this treatment should not be applied in bursæ connecting with joints. We have injected such bursæ notably in the popliteal space and about the elbow-joint with excellent results and without any untoward effect to the joint. However, in the injection of bursa which might communicate with a joint one should proceed with caution.

The usual reaction after injection varies from slight redness and tenderness to marked signs of inflammation. In every case, however, the inflammation subsides within the two weeks' period between injections without infection or sloughing.

The following case reports serve as examples of the clinical application of this treatment, in the more difficult cases.

Fig 1 is a case of a white adult, aged fifty-four years, complaining of a "lump" in the left elbow of one year's duration. After complete study the diagnosis of bursitis about the left elbow-joint was established. December 2, 1930, five cubic centimetres of turbid straw-colored fluid were aspirated and two cubic centimetres of sclerosing fluid

VICTOR CARABBA

were injected through the aspirating needle. Patient complained of some heat, redness and slight pain for three days, which then subsided.

December 15, 1930, three cubic centimetres of turbid fluid were aspirated and two cubic centimetres of sclerosing fluid injected. December 31, 1930, two cubic centimetres of blood-tinged turbid fluid were aspirated without any further injection of sclerosing solution. Fig 2 represents the result of the case. December 30, 1930, the bursitis had completely disappeared. At this time, on routine Wassermann examina-



FIG 3—Bursitis in right popliteal fossa of six months' duration

tion, it was found that the patient had syphilis and he was referred for treatment. The bursitis disappeared in spite of the existence of syphilis.

Fig 3 is a case of a white male, aged fifty-two years, a carpenter, complaining of swelling at back of right knee for six months' duration, since July, 1930, with pain and swelling for three weeks since November 1, 1930. The diagnosis of chronic bursitis in right popliteal fossa connecting with knee-joint was made. Rontgen-ray and other laboratory tests were negative.

November 22, 1930, sixty cubic centimetres straw-colored fluid obtained. One

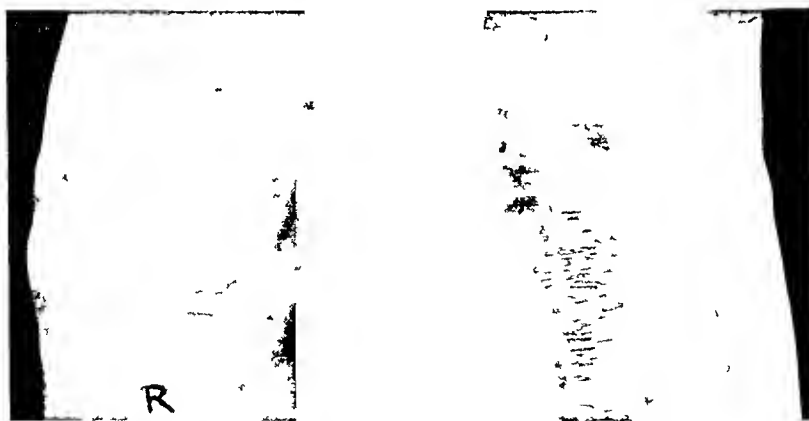


FIG 4—Bursa completely obliterated with four injections of sclerosing solution with no recurrence after two years' observation

and a half cubic centimetres sclerosing fluid injected. November 30, 1930, thirty cubic centimetres fluid aspiration, some tenderness. One cubic centimetre sclerosing fluid injected. December 28, 1930, swelling decreased in size. Some tenderness. January 8, 1931, forty cubic centimetres of fluid aspirated. Two cubic centimetres injected. January 21, 1931, seven cubic centimetres fluid aspirated. Two cubic centimetres sclerosing fluid injected. No pain. No swelling. February 14, 1931, no recurrence.

Fig 4 shows the result. The bursitis has completely disappeared without any further recurrence after follow-up examinations.

Cysts—The following types of cysts have been treated by the injection method. Mucous cysts (buccal mucous membrane), thyroglossal cysts, branchial cysts, sebaceous cysts, ranula.

Mucous Cysts of Mouth—These cysts are usually very resistant to excision, electrocoagulation and radiation. The injection treatment gives excellent results.

The cyst is aspirated of its thick mucinous contents and one-half of one cubic centimetre of solution is injected. An 18-gauge needle should be used as the thick secretion flows with difficulty through needles of smaller bore. Within one week the cyst cavity will be obliterated and replaced by a "pea"-sized mass which will be absorbed within one month. In the cases which we have treated a single injection has sufficed. However, more resistant cases may be encountered and in that event re-injection or incision may be necessary as in treatment of bursæ.

Thyroglossal and Branchial Cysts—Treatment of these cysts is identical to the treatment of bursæ with the exception that two or more injections are necessary to effect a cure. The dosage of the sclerosing solution varies from two to four cubic centimetres depending on the size of the cyst and also the age of the patient.

In young children smaller doses, such as one cubic centimetre should be used. In the majority of these cases there is a slight inflammatory reaction of which the patient should be warned prior to injection. Often it takes as long as three weeks for this inflammation to entirely subside, and thus injection every three weeks instead of every two weeks is indicated.

Sebaceous Cysts—Though excision of sebaceous cysts is the procedure of choice, for cosmetic reasons, or because the patient refuses surgical intervention, the injection method of treatment may be used. The most applicable locations are cysts of the face and neck. The cyst is incised by making a quarter-inch incision under novocaine anæsthesia and its contents thoroughly expressed. The cavity should then be washed out with saline, under pressure, by using a needle and hypodermic syringe.

Sufficient sclerosing fluid is injected to fill the cavity. The excess will flow out of its own accord onto the dressing. Dressing should be done every two days until the cyst disappears. At each dressing care should be taken that the opening of the cyst cavity remains patent for free drainage. At every other dressing a small amount of fluid is injected into the cyst cavity if necessary.

A benign inflammatory reaction occurs in the majority of cases. Usually the cyst completely disappears in three or four weeks. In treating sebaceous cysts of certain location such as the scalp the actual cyst wall becomes completely detached from the surrounding tissues and can be picked out in one piece through the opening originally made for injection and drainage. It is a good plan to inject one-quarter to one-half cubic centimetres of

sclerosing fluid directly into the cyst several days before incising cyst so that there is thorough liquefaction of the cyst contents. This procedure causes a moderate inflammatory reaction. While this preliminary injection is not necessary it is one to be recommended.

Ranula—While an apparently benign surgical condition, ranula is very annoying and distressing to the patient and it is not readily amenable to surgical intervention unless the procedure be extensive and radical. The injection method as employed has proven at least in the cases (4) so treated a simple and effective method.

The mouth is washed out with sodium perborate solution or any other mouth wash. A small area at the summit of the ranula is dried with a sterile pledget of cotton on a swab and painted at that point (one-quarter inch in diameter) with tincture of iodine. Using a fine hypodermic syringe and 2 per cent novocaine solution a small wheal is raised in the sterilized area. An 18-gauge needle (ordinary Wasseimann needle) on a five- to ten-cubic-centimetre syringe is introduced through the anesthetized area into ranula cavity



FIG 5—Ranula of one year's duration



FIG 6—Ranula obliterated with no recurrence after two years' observation

and its contents thoroughly aspirated. Through the same needle one-half to four cubic centimetres of sclerosing solution are injected. The needle is then immediately removed and pressure applied for five or ten minutes at the site of injection so that there is no leakage and the lining wall of cyst is acted upon by the solution. The patient usually complains of a burning sensation which subsides in a few minutes. There may be a secondary inflammation in the cyst wall which readily subsides in two or three days. Curiously enough, the needle puncture wound remains open for a long time, giving drainage to the ranula. This opening closes invariably and the ranula recurs usually to one-third or one-half the original size. This occurs in from two to three weeks, at which time reaspiration and reinjection are necessary. It is interesting to note that at this stage the ranula wall is thickened and inelastic. The same procedure for reinjection is used as before. At each successive reinjection the recurrence is smaller and smaller until there is complete disappearance. The accompanying case is an illustration.

Fig 5 shows a case of ranula of one year's duration in a young woman. September 26, 1930, three cubic centimetres of a thick seromucous secretion were aspirated and one cubic centimetre of sclerosing solution was injected through the aspiratory needle.

October 6, 1930, ranula completely disappeared except for a slight loculus, which was not injected. October 17, 1930, loculus increased in size, being three-quarter inches in length and three-eighth inches in diameter. At this time one-half cubic centimetre of sclerosing solution was injected into loculus. Loculus completely disappeared until November 30, 1930, a one-quarter-inch loculus recurred. This was injected with four minims of sclerosing solution. Many follow-ups on this case show no further recurrence since that time (Fig 6)

Sinuses—The injection treatment has been applied successfully in chronic sinuses (of non-tuberculous, syphilitic or malignant nature), as thyroglossal, branchial and dermoid-cyst sinuses. The sinus is probed to determine its extent and also roentgenographed after lipiodol injection for the same purpose. A 25-gauge Luer syringe needle is broken off at the base and the remaining base is used as a canula for injecting sinus under pressure. Using the usual sterile precautions the base of the needle is attached to a two-cubic-centimetre Luer syringe containing sclerosing solution. Introducing the canula in the mouth of the sinus the sclerosing solution is injected under pressure and held in that position for several minutes or the canula is withdrawn and pressure applied at the opening of sinus to prevent immediate leakage of the injected solution. The excess fluid is then allowed to drain spontaneously.

As a rule there is only a temporary burning sensation but in twenty-four to forty-eight hours a marked inflammatory reaction occurs. The inflammatory reaction consists of redness, swelling and some pain. There is no general reaction and the local one readily subsides under the regime of wet dressings. Usually a single injection closes the sinus for a long time. Our single injection cases are too recent at present to allow us to judge of their permanency. In those which recur reinjection should not be attempted until all inflammation has subsided and definite secretion is again pouring forth from the sinus. The sinus is considered as closed until there is recurrence of drainage. Reinjection is repeated until condition is permanently healed. We are not in this preliminary report able to give the limits of the number of injections necessary. We only can say that one or more are necessary.

Hemangiomata—Hemangiomata of the tongue, lips, face, *etc*, have always presented great difficulty to surgical intervention whether it be by sharp dissection, electrosurgical methods and even radiation. The injection method by sclerosing solution has simplified their eradication. When one excises a hemangioma of lip or tongue there is danger of marked hæmorrhage and the cosmetic results on the local areas operated on are always questionable. In the injection treatment, however, there is no interference with the local healthy parts nor is there any sloughing. To treat the hemangiomata of the lip or any other part of face the usual aseptic and antiseptic precautions are taken. A 25-gauge needle connected with a Luer syringe (two cubic centimetres) containing sclerosing solution is introduced at the base of the hemangioma going through healthy tissue and ending in the hemangioma proper. Blood at times can be aspirated but that is not necessary since the

needle can be readily felt within the cavity of the hemangioma. From 2 to 5 cubic centimetre sclerosing fluid is injected and needle withdrawn. The reason for introducing the needle from healthy tissue into the tumor is to avoid post-injection hæmorrhage and sloughing, or sloughing and hæmorrhage. Immediately after injection the hemangioma becomes firm, slightly swollen, grayish in color and slightly tender. As soon as the tenderness subsides reinjection may be repeated. This procedure should not be repeated, however, more often than every two weeks. As a rule, hemangiomata of the tongue require a single injection while those of the lips and face two to five injections depending on size of lesion. Invariably we have been able to completely cause the disappearance of the lesion without any sloughing, general reaction of any distortion of the area involved. The patient may be sent home directly after injection, thus making it an office procedure. The action of the solution seems to be the same as in the varicose vein injections.

Fig 7 is a case of multiple hemangiomata of tongue in a twelve-year-old girl. Five minims of sclerosing solution were injected into each of the two hemangiomata.



FIG 7—Multiple hemangiomata of tongue



FIG 8—Hemangiomata completely obliterated with a single injection. No recurrence after two years' observation.

October 1, 1930. The masses became hard and pink in color and completely disappeared within one month. There was no pain, no sloughing nor any other untoward symptoms. Fig 8 shows the final result. No recurrence noticed after long period of follow-up.

Ganglion—Ganglia have not responded to the injection treatment as well as the other conditions described. They are treated in the same way as bursitis, using, of course, the same technic and precautions. If a ganglion is unilocular and the contents not organized to a great extent, one obtains brilliant results. On the other hand, the multilocular organized ganglion does not lend itself easily to the injection treatment for obvious reasons.

External Hæmorrhoids—These are not usually treated by the injection method using the usual preparations for injecting varicose veins. With the sclerosing solution, however, one can readily treat such lesions by using the same technic as injecting hemangiomata. The importance of injecting the external hæmorrhoid by introducing the needle from healthy tissue into hæmorrhoid is here stressed. As a rule there is marked swelling of the hæmorrhoid which gradually subsides and is completely obliterated. A single

injection usually suffices of from 1 to 3 cubic centimetre. No general reactions are obtained. Locally there is a temporary burning sensation which readily subsides without sloughing. If injection is made directly into external hæmorrhoid surface oozing and sloughing may occur at site of injections.

Vaginal Varices—These can be treated readily using the sclerosing solution. The veins are injected with 1 to 2 cubic centimetre in one or two segments of the varices weekly until they disappear. No sloughing or general symptoms occur.

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ASEPTIC END-TO-SIDE ILEOCOLOSTOMY CLAMP METHOD

TECHNIC AND STATISTICAL DATA

By FRED W RANKIN, M D

OF LEXINGTON, KY

AND

A STEPHENS GRAHAM, M D

OF RICHMOND, VA

SINCE the original description⁷ of the method under consideration there have been a considerable number of requests for a more detailed description of the technic involved and for illustrations that will more clearly depict the various steps in the procedure. With this in mind, and in view of the fact that sufficient time has elapsed since the original article to enable us to report on the end-results in sixty consecutive cases, both from the standpoint of post-operative mortality and ultimate functional results, we have been prompted to write the present article.

End-to-side anastomosis between the terminal ileum and the transverse colon in instances where it is desired to resect the right half of the colon either immediately or subsequently is in our opinion decidedly the most satisfactory method. The greatest advantage of end-to-side anastomosis is the ability thereby to sidetrack the fecal current from passing over an ulcerating surface. It is our belief that the necessity of a graded operation is largely dependent upon the amount of infection around the primary growth which not only renders immediate resection hazardous but gravely undermines the individual's powers of resistance. Reduction of this infection and rehabilitation are two steps which are not to be gainsaid in successful attack on right colonic lesions. Moreover, the end-to-side anastomosis more nearly approaches the natural anatomical relationship of ileum to cæcum.

Cannon and Murphy² and others have demonstrated by animal experimentation that lateral anastomosis is an unphysiological procedure. Severing the circular muscle fibres in lateral anastomosis abolishes peristalsis in the region of the anastomosis, and the blind pouches at the ends fail to empty completely. The stasis that tends to develop at the new juncture and the concomitant attempt on the part of the normal segment of bowel proximal to this point to overcome the obstacle probably accounts for the upper abdominal discomfort frequently mentioned by patients in whom lateral anastomosis has been established. Cannon and Murphy have further shown that in end-to-end anastomosis there is no stasis of the intestinal contents at the site of the union. However, it has been our experience that in a majority of instances a two-stage procedure is desirable, either because of the general debility of the patient and associated profound anæmia, or due to inflammatory nature of the lesion, or to a combination of both conditions. Under such circumstances it would

be necessary either to form a lateral or an end-to-side anastomosis. Moreover, we have found it convenient in any case first to establish the end-to-side anastomosis between the terminal ileum and the transverse colon and then to determine from the immediate condition of the patient if resection of the right segment of colon is justifiable at the first operation. Not infrequently a patient who appeared in satisfactory condition for a single-stage maneuver at the commencement of the operation proved at the completion of the anastomosis of the ileum to the colon to be in a less favorable state. Careful questioning of many patients who have borne an end-to-side anastomosis over a period of more than a year has failed to elicit histories of abdominal discomfort or pressure sensations at the site of anastomosis, frequently complained of by patients in whom the lateral union has been made.

In contemplating any method of anastomosis between two segments of bowel one must take into consideration certain important technical factors such as ability to accurately approximate the bowel edges, adequacy of blood supply, liability to obstruction from stricture formation or excessive diaphragm, probability of hæmorrhage, and danger from contamination or subsequent leakage at the line of suture. In our opinion, the end-to-side procedure (when the union is between the colon and ileum), is attended by fewer technical difficulties in a greater number of cases, and by less danger, than is the end-to-end anastomosis, notwithstanding the general impression that the converse is true. One frequently encounters considerable disparity in the diameters of the ends of bowel about to be united, even after an attempt is made to compensate for this difference by dividing the ileum at an angle. Further compensation must be made at the expense of accurate approximation by continually taking wider bites on the colonic side and in this manner produce a sort of pleating effect throughout its circumference. Not only does this prevent accurate union but it would seem to enhance the opportunity for contamination and subsequent leakage at the line of suture. In well over 100 cases, which include in addition to our sixty those cases that have been reported to us by other surgeons, there has not occurred a single post-operative hæmorrhage. And in our own sixty cases there was no obstruction at the site of anastomosis, yet in not a single instance was an enterostomy established proximal to the anastomosis. Infection at the site of union and subsequent leakage must be extremely rare since it did not occur in our series, although two patients died and one revealed evidences of peritonitis. In the latter case there was no evidence of leakage at the anastomosis on post-mortem examination but the growth in the cæcum was large and infected, with evidences of subacute perforation. It is energetic palpation of such growths at the time of exploration that will more often be the cause of a fatal peritonitis than leakage about the line of suture. The good clinical results, we believe, bear out the experimental advantages demonstrated by one of us (Graham³) in Mann's laboratory. These animal experiments, which have been previously reported, elicited the following results: absence of post-operative hæmorrhage, absence of leakage at the site of anastomosis, absence of

ircular constriction, almost complete absence of a diaphragm within the lumen, and absence of diminution in the diameter of the lumen

The theoretical objections to the clamp method of anastomosis such as have been recently made by Briggs and Whitaker¹ cannot stand in face of practical results. Similar objections have been frequently raised in regard to the basting-stitch method of Keri,⁵ but many surgeons, including ourselves, have convincingly demonstrated by practical application of this very satisfactory procedure that the fear of obstruction from the infolding of too much tissue, or of hæmorrhage, need not be any greater than in open anastomosis of the intestines.

In sixty consecutive ileocolostomies in which the clamp was employed, there were four operative deaths, or a mortality rate of 6.6 per cent. One of these who died was aged eighty-one years and at necropsy a marked acites and bilateral pneumothorax were noted. Another, aged fifty-seven years, died of peritonitis but without evidence of leakage at the line of suture. The growth in this case showed evidences of subacute perforation. Still another died of pneumonia. The fourth to die was a patient in whom metastases were found throughout the abdomen, with pronounced involvement of the liver. It was assumed that he died of hepatic insufficiency. There was no evidence of peritonitis, obstruction, cardiorenal pathology or pulmonary complications at necropsy. All four were operated on for carcinoma of the right segment of the colon. Forty-two of the series were diagnosed carcinoma of the right colon, nine hyperplastic tuberculosis, four infective granulomata, one an irreducible intussusception, two fæcal fistule, one as fibroma of the cæcum, and one as extensive adhesions. In two instances the operation was performed solely as a palliative procedure because of impending obstruction.

Technic—If one can determine in advance that the contemplated resection will not be attempted at the initial operation, there is an advantage in making a left rectus incision which centres on the umbilicus. This permits subsequent entrance into the abdominal cavity through a right rectus incision, unhampered by possible infection of the primary wound. Otherwise a right rectus incision is made in the first instance. The liver and aortic glands are first palpated to determine the presence or absence of gross metastatic implants, and finally the growth and the lymphatics adjacent to the continuing portion of bowel are visualized when possible, then palpated. The latter manoeuvre should be conducted with considerable circumspection and great gentleness. Timidity here is far more a virtue than is boldness since should an abscess be present, one may very easily and unsuspectingly insert a finger into it. Moreover, the spread of infection from primary growth throughout the peritoneal cavity by the examining hand because of the number and virulence of the organisms in and about the growth is an easily demonstrated danger.

The terminal portion of the ileum about ten to fifteen centimetres from the ileocæcal valve is brought into the wound. Ordinarily it will be found necessary to tie but a few of the terminal branches of the mesenteric vessels just before they enter the intestinal wall. By avoiding the larger vascular branches and therefore disturbance to the circulation of the bowel, the technic is simplified and time is saved in that the necessity for removing a segment of bowel is eliminated. In order to secure as large an opening in the intestine as is possible the special clamp is applied to the ileum at about an angle of 45° (Fig 1). A Payr, or any other suitable clamp, is applied distal to the first and as close to it as is possible and the bowel between them is divided with a cautery, the end

toward the cæcum is invaginated and dropped back into the abdomen, to be removed with the colon at subsequent resection. A point is now selected on the anterior surface of the transverse colon, ordinarily at about the juncture of the proximal and middle thirds unless the growth is at the hepatic flexure, in which case a more distal point is chosen (Fig 2). Allis forceps then are applied to the colon sufficiently far apart to assure an opening comparable in size to the diameter of the ileum and with these forceps elevated the selected segment of colon is fixed by the free blade of the special clamp, one blade of which already contains the proximal portion of ileum. The elliptical piece of colon which protrudes above the closed blade of the clamp is removed with cautery, leaving the cauterized edges of the two pieces of bowel occupying positions exactly opposite each other (Fig 3).

The clamp and the mobility of the bowel permit easy manipulation in establishing the anastomosis. The clamp is now turned completely over making the handle point away from the operator so as to bring the posterior side of the bowel into view (Fig

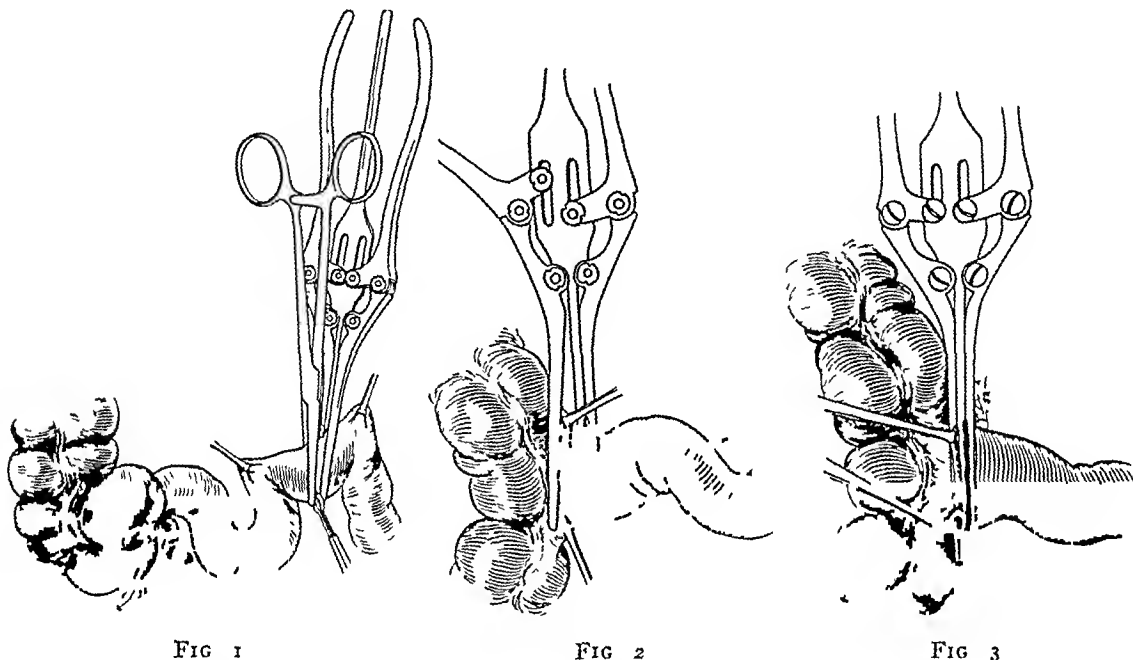


FIG 1

FIG 2

FIG 3

FIG 1—Application of clamp to ileum. The blood supply in the mesentery has been tied off and the special clamp is applied at an angle so as to obtain a wider lumen for the anastomosis. The bowel is divided with cautery.

FIG 2—The clamp is shown being applied to a point selected on the transverse colon for the colonic end of the anastomosis.

FIG 3—An elliptical portion of the colon is being removed by cautery to make an opening in its lumen and the small bowel is shown approximated at this point.

4) This permits accurate approximation of the peritoneal coats of the bowel on the under surface of the anastomosis, because here the two arms of the bowel are in juxtaposition. A continuous suture (our preference is chromic catgut to which a curved needle is welded) is employed and it is tied at one end and locked at the other, the two ends are left long in order that the ends of the anterior suture may be tied to them after removal of the clamp. The clamp is now turned back to its original position and starting with a new suture (this should be an invariable rule) the anterior line of suture is applied by means of a continuous Cushing stitch which passes over the upper surface of the clamp, ties are not made at either end at this stage since to do so would defeat the purpose of this inverting type of suture (Fig 5). Preparations are now made for removing the clamp. An assistant grasps one of the long ends of the posterior suture in order to steady the bowel, and as the operator withdraws the clamp, the blades of which have been opened slightly, the assistant draws his end of the anterior suture taut, thus commencing the process of inversion. When the clamp has been completely withdrawn, the operator draws his end of the anterior suture taut and in this manner completes the

inversion. The agglutination of the two ends of the bowel under the steady pressure keeps it intact as this manoeuvre is carried out. Leakage at this stage has not occurred in any of our cases. The two ends of the anterior suture are now tied with the corresponding end of the posterior suture. Another layer of sutures, either continuous or interrupted is inserted around the entire anastomosis and tags of fat and omentum are attached at both ends as a precaution against leakage. At this stage it is well to force the wall of the colon ahead of the fingers until the fingers are felt to have passed through the anastomosis, thus to break out the agglutination which forms a diaphragm (Fig 6).

Although we did not establish an enterostomy proximal to the anastomosis in any of our 60 cases, we are cognizant of its potential value under certain circumstances and believe that thorough consideration should be given to its employment in every case. Pringle⁶ believes that death in acute septic peritonitis is due to intestinal toxæmia secondary to paresis of the inflamed intestine rather than to absorption of the products of the suppurative inflammation of the peritoneum. Handley⁴ and others concur in this opinion.

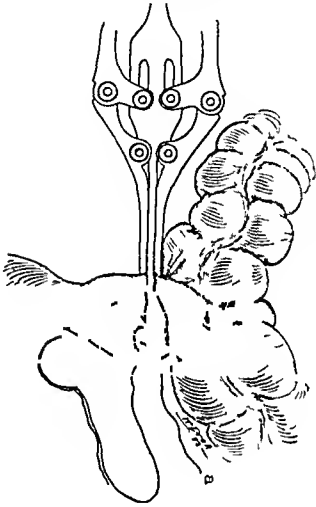


FIG 4

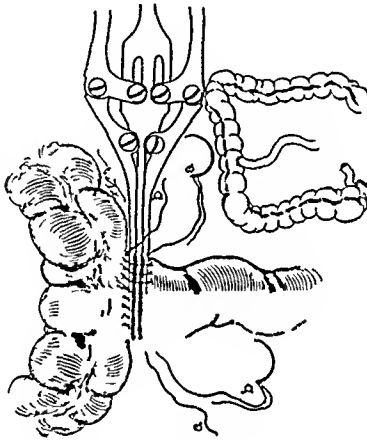


FIG 5

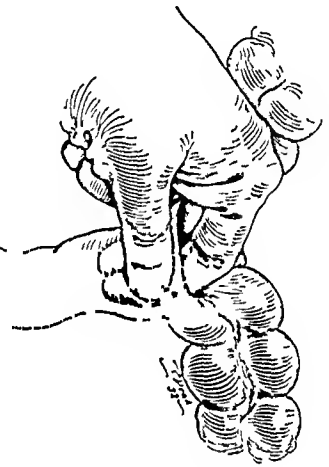


FIG 6

FIG 4—Ileocolostomy over a clamp. Posterior layer of sutures anastomosing the ileum and transverse colon. Clamp is turned over.

FIG 5—Ileocolostomy over a clamp. Anterior layer of sutures applied. (a) Posterior suture, (b) anterior suture. Insert shows the operation completed.

FIG 6—The fingers introduced through the anastomosis to break up the agglutination which forms a diaphragm.

If this is true, then enterostomy established at the time of operation should prove a sound precautionary measure as regards the probable development of peritonitis. Moreover, enterostomy possesses the very desirable feature of lessening intra-intestinal pressure which might produce undue tension on the line of suture.

The abdominal wound is closed in the usual manner and without drainage. We consider it important in these cases always to insert a rectal spool or rectal tube, which is left in place, except for cleansing, during the first seventy-two hours in order to prevent an increase in the intracolonic pressure.

The details of the pre-operative and post-operative care of such cases have recently been outlined by Rankin, Barger and Buie⁸ and unquestionably are highly important to comfortable convalescence.

SUMMARY

(1) In cases of carcinoma of the right half of the colon, it is our feeling that aseptic ileocolostomy between the terminal ileum and the transverse colon followed by resection of the right segment at the same stage on a subsequent one is the procedure of choice.

(2) The employment of end-to-side anastomosis rather than lateral anastomosis is urged in this particular instance because of the very desirable feature which the end-to-side method passes over the lateral in sidetracking the faecal current and allowing as much reduction of local inflammatory reaction around the growth as is possible. Moreover, the end-to-end anastomosis more nearly approaches the natural anatomical relationship of ileum to caecum.

(3) A technic which employs the use of a special clamp, the results of which have been recorded in sixty cases, is described in detail.

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TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD APRIL 3, 1933

The President, DR JOHN SPEESE, in the Chair

CALVIN M SMYTH, JR, M D, Recorder

OSTEITIS FIBROSA CYSTICA GENERALIZATA

DR GEORGE M DORRANCE reported the case of a woman, aged forty-six, first seen in May, 1931, complaining of pain in the right upper jaw, which she stated began a year previous. The pain was distributed to the region of the first right upper molar. Some discomfort was also experienced in the pre-molar area on the upper left jaw. At that time the upper right molar and upper left pre-molar were extracted. Immediately following this extraction the right superior alveolar process began to enlarge. Eleven months later the soft tissues of the right side of the face up to the nose became slightly swollen. At this time, pain commenced in the right ear and right side of the neck, dull intermittent headache was also noticed. There had been no history of pain anywhere else in the body. No fractures, hypotonia, nausea or vomiting. With the exception of a mass on the right side of the neck over the thyroid region which the patient had noticed for the past several years there were no symptoms referable to any other part of the body. The right side of the face was slightly larger than the left. Nasal septum deviated to the right. A symmetrical enlargement involved the alveolus of the right superior maxilla extending to the side of the hard palate. There was a diffuse, smooth swelling on the right side of the neck. The rest of the physical examination was essentially negative.

X-ray examination of the teeth and alveolar margin revealed a definite erosion of the upper right alveolus below the maxillary antrum, involving an area of three centimetres in length and two centimetres in depth between the second molar and bicuspid. This area was fairly well circumscribed and contained many small bodies of the density of enamel, scattered irregularly throughout the area. The roentgenologist stated that there was a mass the consistency of bone projecting from the right maxilla downward and outward, one centimetre in diameter, outline of which is regular. The skull—the anteroposterior view here showed little change. The lateral view showed an area in the right fronto-parietal region of decreased density, rather sharply outlined, which stereoscopically appeared to be destruction of the inner table. This measured seven centimetres horizontally and nine centimetres obliquely. X-ray studies of the entire bony skeleton revealed only a peculiar rounded shadow of increased density in the lower third of the left femur. Blood calcium on successive days was 10.95 and 11.01 milligrams per 100 cubic centimetres of blood.

Operation June 5, 1931, the alveolar margin and tumor were excised.
Pathological Report—Osteitis fibrosa cystica

The patient improved, but by December the lesion had not completely healed, the anterior part of the scar being reddened and a sequestrum being disclosed. X-ray revealed a similar appearance to that previously described.

ALCOHOLIC INJECTION OF GASSERIAN GANGLION

A second operation was performed April 4, 1932, when the alveolar margin was removed up to the canine tooth. The bone was curetted as long as soft spongy material could be removed, leaving a smooth solid surface. The pathologist again pronounced the condition to be osteitis fibrosa cystica. On July 6, a small reddened area on the lateral aspect of the right upper jaw was evident. The patient complained of some soreness. In view of the fact that there were areas of decalcification in various bones, it was suggested that the tumor in the neck be removed to determine whether it was thyroid or parathyroid. Therefore, July 7, a colloid cystic mass, the size of a small peach, was enucleated. Search for a parathyroid adenoma or enlargement was unavailing. The pathological diagnosis was colloid goitre.

September 13, 1932, X-ray studies revealed some remaining calcium deposit about the lesion on the right side but no spread. Up to February, 1933, the patient felt perfectly well, but a check-up on the blood calcium revealed that it was 19.2 milligrams per 100 cubic centimetres and the blood phosphorus 2.1 milligrams per 100 cubic centimetres of blood. It was decided to give X-ray therapy over the parathyroid area. After six weeks the blood calcium dropped to 12.01 milligrams per 100 cubic centimetres of blood. X-ray studies at the present time show the alveolar margin to have been removed. Skull—There is an increase in the original process in the fronto-parietal region in all directions by two centimetres. There is no X-ray evidence of any other bony lesion except the left femur, the exact nature of which is undetermined and in which there has been no increase in size. The patient is being maintained under observation and further studies will be made.

DR DEFOREST P WILLARD said, regarding a similar case in which the calcium was rather high and the blood phosphorus low, that with a high-phosphorus diet containing considerable viosterol, the patient's condition greatly improved. The X-ray pictures during the last month showed a great deal of recalcification without any parathyroid or thyroid treatment. There has also been a large improvement in the decalcified area of the skull.

ALCOHOLIC INJECTION OF GASSERIAN GANGLION FOR TIC DOULOUREUX

DR GEORGE M DORRANCE reported the case of a man, aged thirty-two, who thirteen years ago had four abscessed teeth in the right inferior maxilla. The second molar was extracted at that time. Following this extraction he continued to have pain and subsequent X-ray films showed a number of abscesses. Then all the abscessed teeth on the right side of the jaw were extracted. This was followed by osteomyelitis. Two months following this extraction the pain was very severe. Although a chlorazene mouth wash was instituted, his condition did not improve. Some time later a solution of potassium permanganate to his gums was substituted, under which treatment the gums healed and he had no further pain for about three years.

In 1923, he developed exquisite pain in the right lower jaw. In December of that year he went to the Evans Institute for treatment and they referred him to the Neurological Clinic at the University of Pennsylvania Hospital. He was admitted to the hospital where he remained for four weeks. During this time the pain was so severe that he was given hypodermic injections which he thinks were morphine. At this time, he states, Doctor Frazier injected his nerve with alcohol. This is taken to mean the nerve at the foramen ovale. He had relief from pain for four years after this injection.

In 1927, he again began to have pain for which he consulted an osteopath, who under chloroform anæsthesia treated his "cervical and thoracic nerve regions." He had a number of treatments which gave complete relief for a long time. Four years ago he developed a right-sided tic douloureux principally in the third division. An attempt to inject the nerve did not obtain any relief. The surgeon then trephined the mandible and avulsed the inferior dental nerve. Following this the patient had marked relief for a year, at the end of which time the entire inferior dental canal was opened up. At the angle of the mandible were found the root of a tooth and a small neuroma. Following this the patient had complete relief until September, 1932, when the pain recurred principally in the tongue and over the anterior part of the ear.

When first seen by the reporter, he had typical symptoms of right-sided tic douloureux principally in the third division.

On October 15, 1932, by the Hartel method, Doctor Dorrance injected the ganglion and obtained anæsthesia over the entire distribution of the fifth nerve. He now has anæsthesia over all three branches. He has had no difficulty with the cornea nor any return of pain.

The reporter agreed with W. Harris, of London, that the results of the ganglionic injection are so satisfactory as to justify its use in tic douloureux, and for pain in malignant disease. He even goes so far as to say no case should be operated upon that can be injected.

DR CHARLES F. NASSAU said that although Doctor Dorrance was probably right in his individual case, unfortunately it is not true that injection of the gasserian ganglion with alcohol is without danger. There have been a number of accidents. Even in the hands of very good men, loss of vision has occurred. These injections almost always have to be repeated. Why not give the patient the benefit of permanent cure by operation? However, as Professor Kocher said in speaking of cholelithiasis, "Gall-stones first of all belong to the patient and then to the surgeon," but they are the patient's to keep if he so chooses. The speaker believed that such patients should be referred to that brain surgeon whose work shows the most perfect post-operative results. It is not an operation to be attempted by the general surgeon.

DOCTOR DORRANCE said that when he first began injecting the second or third division of the fifth nerve outside the skull, he heard the same objections as Doctor Nassau now made. The men who made these objections are now injecting the nerves. There are a large number of patients who refuse to have the major operation. This was one, the speaker has had about fifteen others. The patients have been sent to him because they refused to have the major operation and none of the terrible consequences which Doctor Nassau mentions has occurred. We ought to be able to inject a certain number of these ganglia. Dandy approaches the division of the root of the fifth nerve in one way, Frazier in another and Cushing still divides the entire root. Surely in certain cases of malignancy injection is the method of choice and the results have been satisfactory. In cases of tic douloureux, if the surgeon were as skilled in injecting the ganglion as in performing the operation, there would be many more injections.

MELANOTIC SARCOMA OF SMALL INTESTINE

MELANOTIC SARCOMA OF SMALL INTESTINE

DR ELDRIDGE L. ELIASON reported the case of a woman, sixty-two years of age, who was admitted to the Medical Ward of the Hospital of the University of Pennsylvania August 6, 1932. For seven months prior to admission she had been suffering from pain in the mid-abdomen. The pain was

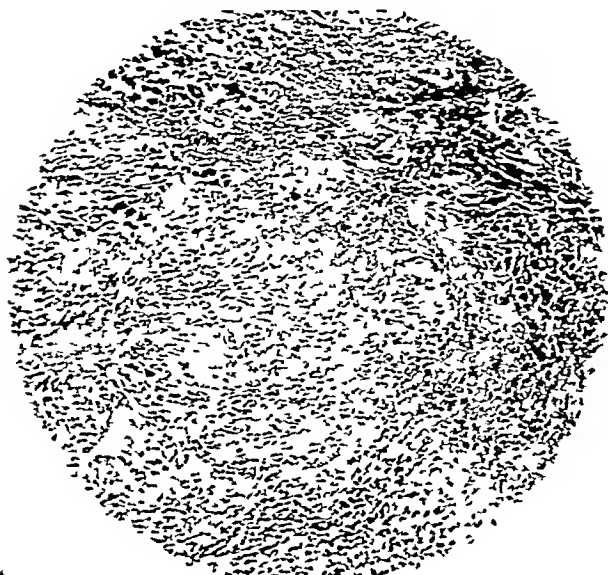


FIG 1



FIG 2

FIG 1—Melanotic sarcoma removed from inner aspect of left thigh October 27, 1930, two years prior to resection of polyp. Magnified fifty-seven times

FIG 2—Jejunal polyp. Melanotic sarcoma. Low power magnification

sharp, continuous and had been increasing in severity. Vomiting occurred two days prior to admission, although much of the food consumed had been retained. There had been a gradual loss of weight, from 150 to 120 pounds

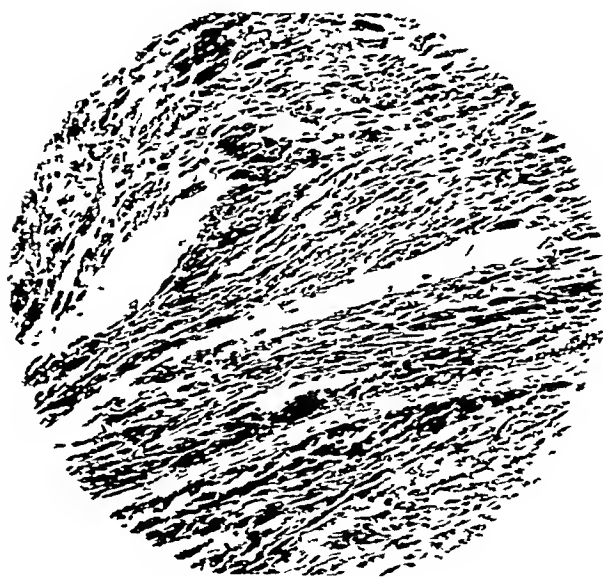


FIG 3

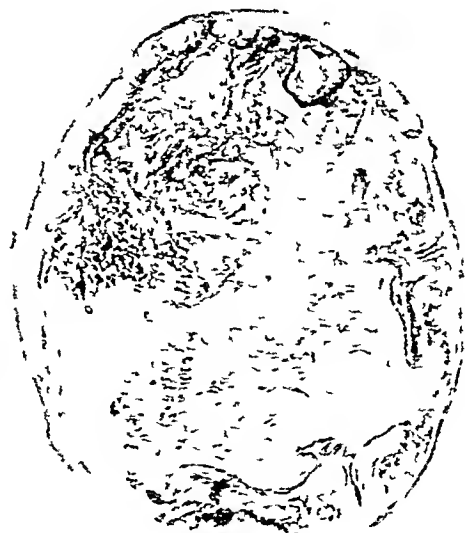


FIG 4

FIG 3—Jejunal polyp. Melanotic sarcoma. Magnified fifty seven times

FIG 4—Mesenteric metastasis. Low power magnification

Five months prior to admission. March, 1932, the patient had been thoroughly studied at Mt Sinai Hospital, at which time the above complaints had been of rather brief duration. The patient had had a tumor removed from the upper and inner aspect of her left thigh October 27, 1930. (Figs 1, 2

3 and 4) The tumor had then been present for a year. It was found to be easily movable beneath the skin, unattached to the skin or underlying structures. Section of the tumor showed it to be a melanoma. The patient was an elderly Armenian woman, unable to understand or speak English. Her skin was dark. She was suffering from severe abdominal pain. There was decided evidence of emaciation.

The abdomen was scaphoid, with relaxed, loose, striated skin. There were no scars. Slight fullness below the ensiform suggested an epigastric mass. Peristalsis was not visible, and barely audible. The presence of an epigastric mass was not confirmed by palpation. There was epigastric tenderness, the site of the abdominal pain. There was no muscular resistance. No fluid was demonstrable. There was a flat, pigmented mole on the external aspect of the right leg. A scar in the left groin marked the site of previous tumor excision. The remainder of the physical examination was without importance.

Laboratory Data—Complete blood counts, urine, blood Wassermann, Van den Bergh, blood sugar, and fractional gastric analysis after test meal, all disclosed findings within normal limits. Graham-Cole gall-bladder studies disclosed a non-functioning gall-bladder. Chest X-ray showed an advanced fibrosis of both upper lobes evidently due to tuberculosis. Stools examined after meat-free diet repeatedly showed the presence of occult blood.

Gastro-intestinal X-ray series showed a deformed duodenal cap, there was some deformity in the second portion, with stasis due to some obstacle. The duodenal loop was wide, possibly due to a pancreatic lesion. There was small intestinal stasis throughout due to peritoneal irritation, such as metastases from malignancy.

The œsophagus, stomach and colon were negative.

Operation—Under ether anæsthesia, the abdomen was explored through an upper mid-line (linea alba) incision. When the first portion of the jejunum was examined, several tumors were palpable within its lumen. The mobility of these walnut-sized tumors within the lumen of the gut suggested a polyposis. Within the proximal three or four feet of the jejunum about five or six of these tumors were encountered. Two were found to have produced a puckering of the serosal surface of the gut, through complete, though subserous, involvement of the gut wall. At one point, a partial intussusception had occurred.

Examination of the mesentery of this loop of jejunum revealed a nodule near the root of the mesentery, the size of a walnut, the pigmentation of which suggested a melanotic sarcoma. This tumor did not appear to be a lymph-gland, nor were there other lymphatic glands in the immediate neighborhood.

Because of the extensive involvement of the small gut in a patient of advanced years, a simple procedure was elected for the relief of obstruction. A lateral anastomosis was performed, uniting the jejunum proximal to the first tumor, to the ileum beyond the level of the last tumor. The anastomosis was so planned that two of the polyps were removed by simple ligation of their bases. (Fig 5) The small tumor in the mesentery was enucleated. The patient made an uneventful convalescence and was discharged September 13, 1932, nineteen days after operation. Gross and paraffin sections of the two polypi and the tumor of the mesentery disclosed them to be melanotic sarcomata.

Through the courtesy of the Mt Sinai Hospital and Dr Moses Behrend, sections of the tumor removed from the left thigh were made available for comparison with those of the polypi and mesenteric tumor. They appeared to be the same.

MELANOTIC SARCOMA OF SMALL INTESTINE

Follow-up Reports—In February of 1933, approximately seven months after operation, the patient was ambulatory, with a complaint of constipation. Tumefactions were palpable within the abdomen. She had completed rather extensive X-ray therapy. She was visited recently (March 28, 1933) and found to be bedridden, with abdominal pain, obstipation and vomiting.

The reporter added that sarcoma of the small intestine is a clinical curiosity. The literature is replete with numerous papers on tumors of the small intestine, few of which record melanotic sarcoma. Libman,¹¹ in 1900, collected forty-two cases of sarcoma of the small bowel, and called attention to Tieves'²² case reported in 1899, a melanotic sarcoma of the ileum, with infiltration of the inguinal glands.

Douglas,⁷ in 1912, reviewed the literature on sarcomata of the small intes-

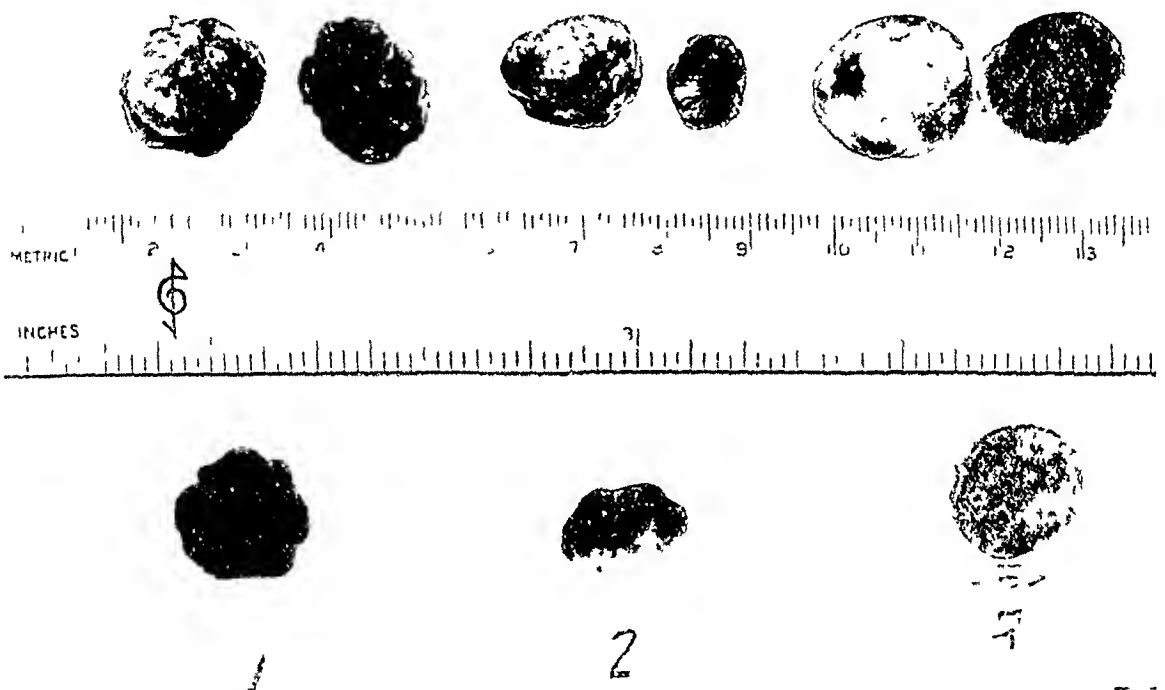


FIG. 5—1 and 2 are the polyps removed from the jejunum. 3 is the mesenteric tumor.

tine and called attention to forty-nine cases, one his own. No melanotic sarcomata were recorded. Clowther,⁵ in 1913, collected a series of 170 cases of sarcomata of the intestines, of which the majority were of the round-cell, lymphosarcoma or spindle-cell type. Five melanosarcomas were observed. Speese,¹⁹ in 1914, collected 101 instances of sarcomata in the small intestine, in ninety-nine of which the type was recorded. One melanotic sarcoma was observed. Chamer and Bonnet³ compiled 100 cases of primary melanomata of the rectum, and commented that generalized metastases in the intestinal tract was observed only three times, and then only at necropsy.

Haggard¹⁰ quoted a series of 21,000 autopsies, in which sarcomata occurred but three times in the small intestine. Goldstein,⁹ in a comprehensive review of the literature up to 1921, collected 130 cases of supposed primary sarcomata of the small intestine. A case of melanotic sarcoma reported by Wilner²⁴ was mentioned.

Raiford¹⁵ recently reviewed the material of the Johns Hopkins Hospital, consisting of 11,500 autopsies, and 45,000 specimens from the department of surgical pathology, and collected but eighty-eight tumors of the small intestine. Malignant tumors of the small intestine comprised 49 per cent of all the gastro-intestinal tumors. Eighteen and one-tenth per cent of the eighty-eight tumors of the small bowel were carcinomata, while 23 per cent recorded two cases of lymphosarcoma of the ileum. Melanotic sarcoma was not mentioned.

Cave,¹ concurrently, collected fifteen cases of tumors of the small intestine from the records of the Roosevelt Hospital in New York City, and recorded two cases of lymphosarcoma of the ileum. Melanotic sarcoma was not observed.

Mon and Walker¹¹ reported three cases of sarcoma of the small intestine, and, from a review of about 200 cases in the literature to date, noted that histologically the round-cell sarcoma, lymphosarcoma and the spindle-cell sarcoma occurred with about equal frequency, while there was an example of almost every sort of sarcoma on record. They concluded that essentially three types of tumor growth occurred. The first type tumor arose from the mucosal surface, and projected into the lumen of the gut as a polypoid mass. The second involved the bowel wall as an extensive tubular or cuff-like infiltration. The third type dangled from the peritoneal surface of the bowel as a pedunculated mass.

The above case is of unusual interest, for it represents an example of the first type tumor, and was proven to be a melanotic sarcoma.

Nine additional cases of melanotic sarcoma of the small intestine have been collected, exclusive of the single cases reported by Tieves²² and Wilner.²⁴

(1) Vander Veer and Kellert²³—Female, aged fifty. Seven months prior to her death she had coughed up a piece of tissue which was found to be possibly sarcomatous. She had suffered from abdominal distress for four weeks, following which laparotomy revealed an intussusception, the reduction of which revealed a tumor mass which filled the entire lumen of the bowel. The section of the ileum bearing the tumor was resected. Recovery was tedious. She died six months later from what appeared to be an extension of the growth in the lungs. No autopsy.

Examination of the specimen disclosed a polypoid tumor mass projecting into the lumen of the bowel from the mesenteric border. The tumor was flat, irregularly circular, black in color and rather firm. The surface was rather smooth, uneven, grayish-black and covered with mucus. The cut surface was deep black, smooth and structureless. The growth appeared to involve the muscle coats, but did not extend to the serosa. Section proved the tumor to be a melanotic sarcoma.

(2) Thomsen²¹ (reported by Vander Veer and Kellert) reported a case of very extensive metastases to the small intestine secondary to a melanotic sarcoma of the big toe.

(3) Rolleston¹⁷ (reported by Vander Veer and Kellert) noted the presence of numerous polypoid tumors in the small intestines, secondary to a growth in the right eye. They were small and resembled mucous polypi.

The growths appeared to start in the mucous membrane, the larger ones occupying the mucous and submucous coats. In this case there were metastases to all the abdominal organs and the bones. The liver weighed sixteen pounds. Microscopically, the tumors were spindle-cell sarcomata.

(4) Cox and Sloan⁴—Male, aged fifty-four. Necropsy disclosed a tumor mass situated about thirty centimetres below the pyloric orifice, and extensively infiltrating the serosa with pigmented tissue for a distance of twenty centimetres. There was no obstruction. The bowel wall was diffusely thickened with the tumor tissue. The mucosa was densely infiltrated, and for a distance of eight centimetres was completely replaced by tumor tissue, showing slight ulceration. There were a few distinct tumor nodules in the mucosa outside this central area of dense infiltration. The lymphatics were all involved. The mucosa of the small intestine showed occasional small pigmented spots, the largest of which were ulcerated. Fifty centimetres below the main mass, one ulcerated nodule of the mucosa was two centimetres in diameter.

It was assumed that the tumor mass arose in the jejunum, with infiltration of the adjacent lymphatics and mesenteric lymphatic nodes, extensive secondary involvement of the liver, gastric and intestinal mucosa, pleura, peribronchial lymph-nodes, heart muscle, brain and the left lung, posterior lobe of the hypophysis cerebri and infundibulum, the peritoneum, vesical mucosa, duum, pericardium, the skull, with slight infiltration of the pancreas, peripancreatic and hepatic lymph-nodes, with occasional metastases in the kidneys, with but one small subcutaneous metastases.

(5) Saphir¹⁸—Male, aged fifty. A melanotic sarcoma had been removed from the region of the right nipple two years prior to death. Autopsy revealed a fungating mass in the proximal jejunum, situated opposite the mesenteric attachment and occupying almost the entire intestinal lumen. The tumor was of soft consistency, dark gray, showing a large amount of black pigment. The surface was ulcerated. The tumor involved the mucosa, submucosa and muscularis. Two smaller tumors in the ileum were of a similar nature. Secondary metastases were observed in the lymphatics, liver and the brain.

(6) Maxwell¹³—Male, aged fifty-two. Three years prior to admission the patient had a mole removed from the right arm. After six weeks of abdominal distress, laparotomy revealed a tumor in the ileum, which was resected. On section the tumor was found to be fungating into the lumen of the gut. The surface was ulcerated. It did not invade the peritoneum. Section showed it to be a malignant melanoma.

Two months later the patient was again operated upon and found to have an intussusception in the ileum, apparently the result of a pedunculated tumor, which was removed. Its character was exactly similar to the tumor previously observed.

(7) Robb¹⁶—Woman, aged twenty-three. Three years prior to her death a tumor had been removed from the left groin, which was well encapsulated. On section it was black and microscopically proven to be a melanoma. There was a melanotic mole on the calf of the leg. Sixteen months prior to death, abdominal distress made its appearance, and a tumor mass became palpable. Laparotomy and necropsy showed the whole circumference of the wall of the second and third parts of the duodenum to be occupied by a melanoma. The lumen was enlarged and lined by the necrotic surface of the tumor. At no point did the growth penetrate the peritoneal coat of the duodenum. Its upper and lower limits were heaped up and sharply defined. No other metastases were found.

(8) Robb¹⁶—Male, aged sixty He had a pigmented mole removed from behind the right ear ten years prior to admission Nine years previously a large mass of glands had been removed from the right side of the neck He was admitted with vague abdominal complaints, and examination disclosed an orange-sized mass in the abdomen At operation the mass was found to occupy the jejunum, sixteen inches from the duodenojejunal flexure No metastases were discovered in the mesenteric lymph-glands or liver The patient died sixteen days after resection Autopsy was not permitted

Examination of the specimen showed the jejunum to be involved by a pigmented growth occupying the whole circumference of the wall of the gut The lumen was enlarged and lined by the surface of the growth, which at no point penetrated the peritoneal coat Microscopically, the tumor was a melanoma

(9) Lund¹²—Male, aged fifty The patient had suffered abdominal distress for about six weeks There was a marked loss of weight Laparotomy revealed two intussusceptions due to two tumors which on section were found to be melanomata on the mucosal surface of the gut There was noted a soft tumor overlying the pancreas, retroperitoneal, which suggested the primary source The skin and eyes were grossly negative

Lund cited a second case, the necropsy of which showed widespread melanotic sarcomata, with none, however, within the lumen of the gut The primary source had been in an eye, which had been enucleated eight years prior to death

Dawson,⁶ in an extensive treatise entitled "The Melanomata" most thoroughly discussed the morphology and histogenesis of these pigmented tumors Ewing⁸ believed that the melanomata arose from the mesoblastic chromatophores, from epithelial cells which had taken on pigment function They may exhibit carcinomatous and sarcomatous structures, or both The primary tumor is usually in the skin, the choroid, iris, conjunctiva, pia mater, arachnoid, rectum and less frequently other organs Cooke² investigated the primary lesions in fifty-three cases of malignant melanomata and found that in over 50 per cent of the cases the skin was the first offender Interestingly enough, but one case was listed as being primary in the jejunum

Saphu¹⁸ believed that one should regard with suspicion a report of primary melanotic sarcoma of the small intestine Lund¹² quoted Mallory who stated that he had never seen a melanotic sarcoma of the small intestine, except those secondary to tumors of the skin or of the rectum

It would appear that the case reported by Cox and Sloan⁴ might possibly be primary in the gut, but it is to be recalled that, at necropsy, there was a small subcutaneous metastasis The tumor removed primarily in our own case was subcutaneous

The symptomatology and diagnosis of the small intestinal tumors have been thoroughly covered in the extensive papers of Speese,¹⁹ Mori and Walker,¹⁴ Struthers,²⁰ and most recently by Cave¹

Lund¹² demonstrated by the X-ray a small intestinal stasis in his recorded tumor It was this finding that led to the suspicion of small intestinal metastases in our own case

CONGENITAL NON-PARASITIC CYST OF THE LIVER

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CONGENITAL NON-PARASITIC CYST OF THE LIVER

DR ELDRIDGE L ELIASON reported the case of a female child, aged three years and nine months, who was admitted to the Hospital of the University of Pennsylvania, December 11, 1932, on account of a lump in the right side of the abdomen (Fig 6)

The child had been perfectly well until she developed a mild pyelitis four weeks prior to admission Examination by her physician had revealed a tumor mass in the right upper quadrant The child had been examined frequently during her first year and her physician was positive that, during that time, there was no abdominal tumor present, at least to palpation She recovered from the pyelitis, but during the four weeks preceding admission there seemed to be a slight increase in the size of the mass, and there was an occasional complaint of abdominal pain, though not severe Except for pus in the urine, there had been no urinary-tract symptoms There was no jaundice, nor were there clay-colored or tarry stools Past medical and family history appeared to be of no importance She was a well-developed, well-nourished child over three years of age, alert, intelligent and unusually cooperative The abdomen contained a tumor mass which occupied the greater part of the right upper quadrant It was smooth, insensitive rubbery in consistence, and without evidence of demonstrable fluctuation The liver, spleen and kidneys were not palpable

Graham-Cole gall-bladder studies did not show any of the dye in the gall-bladder, which on this evidence was concluded to be non-functioning (Fig 7) None of the films showed a gall-bladder shadow which would have been due to the dye, although there was an ample amount of dye in the intestinal tract On the right side there were three definite shadows One was evidently the kidney, the other one the liver, and the third, unidentified, was thought possibly to be a large gall-bladder (Fig 8)

The intravenous urogram showed the kidney pelves, calices and ureters



FIG 6—Röntgenogram showing small intestinal stasis and probable filling defects

to be distinctly visible in the fifteen-minute examination, on which evidence the kidneys were considered to be separate from the tumor mass

The pre-operative diagnosis was massive hydrops of the gall-bladder, due to a congenital defect in the duct

The abdomen was explored under ether anesthesia December 12, 1932 A large cystic mass was exposed and found to occupy the under surface of the liver, extending upward between the two lobes in the region of the central fissure (Fig 9) The cyst was thin-walled and about the size of a grape-fruit On rotation of the cyst and liver upward, the normal, blue, thin-walled gall-bladder could be seen to its outer side The cystic and common ducts were plainly visible The cyst was first evacuated and found

to contain about 400 to 450 cubic centimetres of clear, watery fluid. The sac was then freely opened and found to be lined with what appeared to be a pale epithelium. A cleavage plane was made out between the lining and the outer coat or capsule. The entire cyst was enucleated from its capsule, following which the outer coat was closed at the neck, about a soft cigarette drain (Fig 10).

Convalescence was uneventful, with the exception of a persistence of the pyelitis. The drain was removed nine days following operation, and on the



FIG 7—First roentgenogram taken after absorption of the dye for the Graham Cole gall bladder study. Arrows point to the outlines of the cyst.

eleventh post-operative day the child was discharged in good condition. The wound had closed completely. Four months after operation she has gained five pounds in weight and is without complaint.

The fluid from the cyst was carefully examined. The specific gravity was 1.0095. The pH was 5.0 plus. There were a few fat droplets present, with no fatty acid crystals. A few cholesterol crystals were present. There was no hæmatoidin. Fibrin, white blood-cells and bile pigment were absent. There were but few red blood-cells (probably a result of evacuation). The albumen content was 4.94 milligrams per cent.

while the sugar content was 78 milligrams per cent. A smear and stained specimen failed to show bacteria or ova.

Laboratory Data—Red blood-cell count 4,300,000 per cubic millimetre, with a haemoglobin of 74 per cent. The white blood-cell count was 6,600, with a differential count of seventy-six neutrophils, nineteen lymphocytes, three large mononuclears, two eosinophils and six basophils. The urine was negative except for the presence of a few pus-cells. The faeces showed the presence of bile, but no occult blood.

A paraffin section of the cyst wall showed an inner layer comprising about two-thirds of the thickness of the section, consisting of hyalinized connective tissue. It

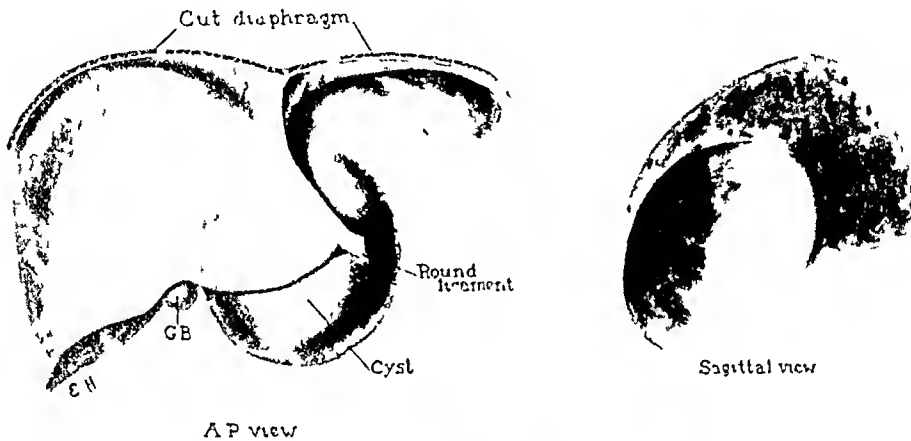


FIG 8—Non-parasitic liver cyst, relative position in anteroposterior and sagittal views

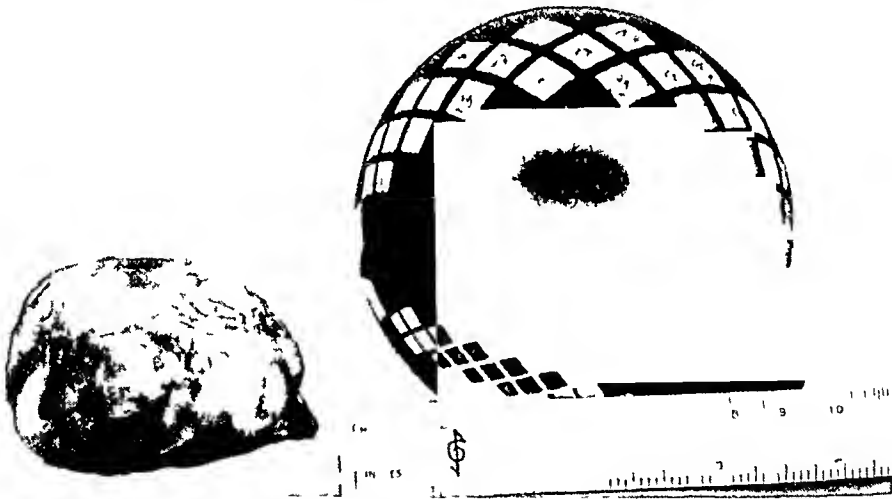


FIG 9—The enucleated cyst filled with cotton, compared to a rubber balloon filled with 400-450 cubic centimetres of air, to demonstrate the actual size of the cyst

appeared that in some areas the inner surface was lined with flattened cells, not unlike endothelia. The outer third of the wall was composed of a matrix of fibrous tissue in which were seen scattered groups of liver cells, an occasional bile capillary and numerous blood vessels. Lymphoid cells were scattered through this tissue layer.

The speaker added that Ackman and Rhea¹ have recently reported a successful operation for what appeared to be a congenital (non-parasitic) cyst of the liver. They referred to the work of Muto and Hanzawa,³ who had

CONGENITAL NON-PARASITIC CYST OF THE LIVER

collected the reports of seventy-five similarly operated cases, sixty-five of which had been recorded since 1900. A few isolated reports of similar cases have appeared in the literature since that time.

The above case is of unusual interest, as were the others reported, because of the speculation as to pre-operative diagnosis, and probable origin of the cyst.

In the papers of McGlannan,² and Ackman and Rhea,¹ the following interesting points are worthy of note. Most of the solitary cysts are found growing from the under surface of the liver, extending to the anterior border of the liver in the region of the gall-bladder.

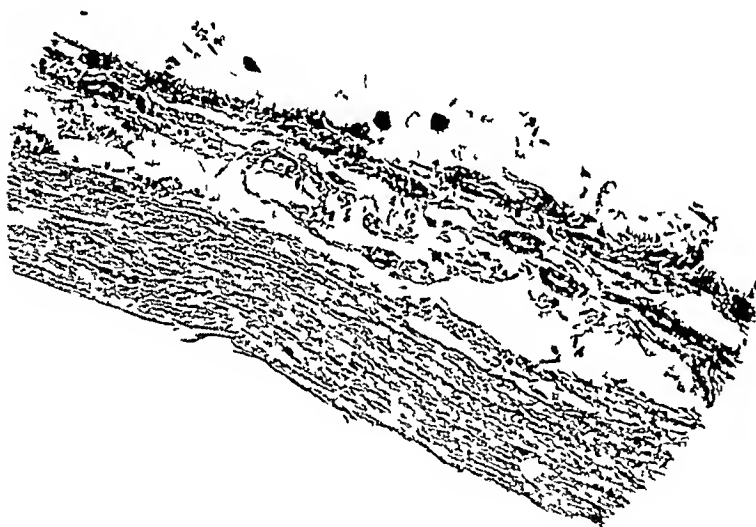


FIG 10—Cyst wall magnified 100 times

The condition is more common in females, the proportion of incidence between sexes being about 4 to 1. Most of the patients are between forty and sixty years of age.

Clinically, a positive diagnosis is difficult because the solitary cysts of the liver had no signs or symptoms sufficiently characteristic to make a pre-operative diagnosis certain. The common diagnoses were chronic cholecystitis, hydronephrosis, mesenteric cyst, ovarian cyst and tuberculous peritonitis. In the recorded case the pre-operative diagnosis was "probably enormous hydrops of the gall-bladder." A diagnosis of liver cyst was not entertained. The gall-bladder function was undoubtedly interfered with by the cyst, although a follow-up Graham-Cole study has not been made.

Ackman and Rhea point out that in general the effect of the non-parasitic cysts on the condition of the patient depends upon the extent of functional

derangement produced in the liver and the organs about the cyst as a result of pressure

Considerable divergence of opinion exists among writers on this subject as to the origin of these non-parasitic cysts. In all probability the majority are of congenital origin, such as lymphatic cysts, blood-vessel cysts, ciliated epithelial cysts, cystic degeneration of the liver and kidneys, bile-duct retention cysts and teratomata. The acquired type would comprise the degeneration cysts, cystadenomata and bile-duct cysts associated with acquired cirrhosis of the liver.

McGlannan favored the origin of the single cysts from aberrant bile-ducts or cystic adenomata developed from the same source. Due to the accumulation of the secretion under varying degrees of tension, the lining and secreting cells became imperfect and their secretion was not likely to be true bile. He pointed thus to the impracticability of determining the exact origin of these large solitary cysts by a study of the structure of the wall or the chemical composition of the contents.

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BISECTION OF THE ISTHMUS IN THE PERFORMANCE OF THYROIDECTOMY

DR JULIAN JOHNSON, by invitation, remarked that as in all matters of taste, so in matters of technic, every one has his preferences. Sometimes the latter are the result of habit, sometimes of an intelligent effort to acquire the best. It is surprising how in little ways there are so many variations in the performance of a thyroidectomy.

In the past at the thyroid clinic of the University Hospital, in the mobilization of the gland the initial step was taken at the superior pole of the right lobe, the lateral aspects and the inferior pole were then liberated and lastly the isthmus was bisected. For the past two years these steps have been reversed so that now Doctor Frazier, as his initial step, bisects the isthmus in sections from below upward. While this procedure has been described by Crile,¹ we feel that it has not received the recognition and use which it deserves. Richter² also has advocated bisection of the isthmus but following the liberation of the superior poles. It has been our experience that if the isthmus is bisected as the initial step, the liberation of the superior poles is made much more simple. The procedure requires no special instrument or clamp. With a stock hæmostat the isthmus is separated (Fig. 11) section by section from the trachea, grasped on either side with Kocher hæmostats and the intervening tissue divided (Fig. 12). This is repeated until the isthmus is bisected. Sometimes it may be difficult to distinguish the lobe from an enlarged isthmus, but a large branch of the inferior thyroid vein approaching

BISECTION OF THE THYROID ISTHMUS

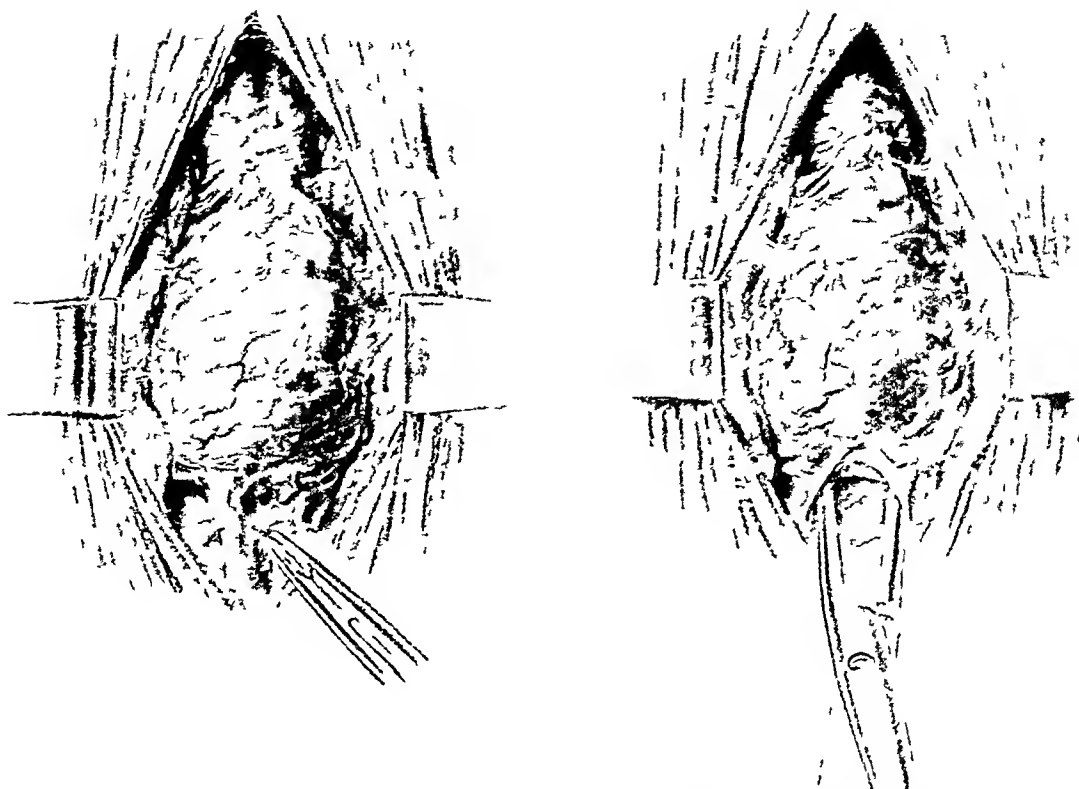


FIG 11—(Left) The hæmostat grasping the divided branch of the inferior thyroid vein, the guide to position of the trachea. The fellow vein to the left is undivided. (Right) The initial step in the exposure of the trachea with a stock hæmostat.

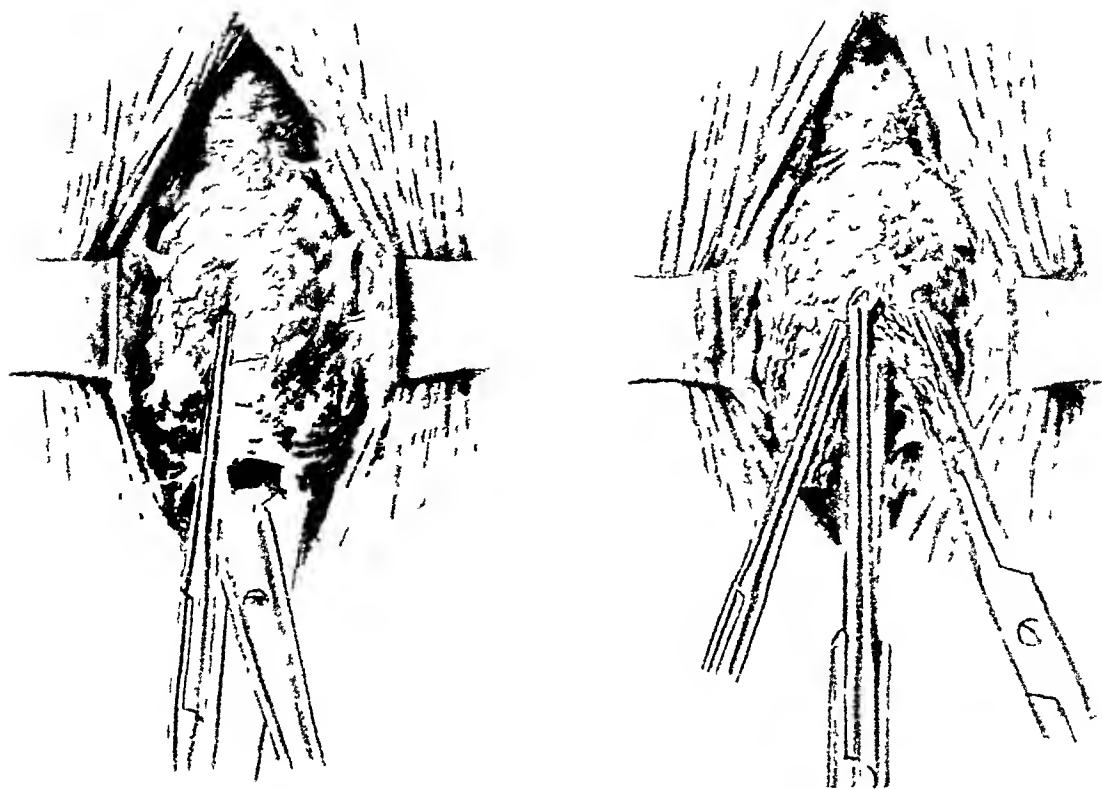


FIG 12—(Left) First section isthmus separated from trachea and Kocher applied. (Right) Two Kocher clamps applied to the first section of the isthmus with division of same.

the lobe on one or the other side of the trachea serves as a useful guide. When the isthmus has been bisected, the tissue intervening between the trachea and the superior pole which usually includes the pyramidal lobe is divided (Fig 13)

This method of attack has simplified the performance of the operation to an extraordinary degree, it simplifies the exposure of both the superior and the inferior poles and later the resection of each lobe. Once we believed the exposure of the trachea predisposed to a tracheitis, to mucous collections and to coughs. We are now convinced that this deserves no consideration.

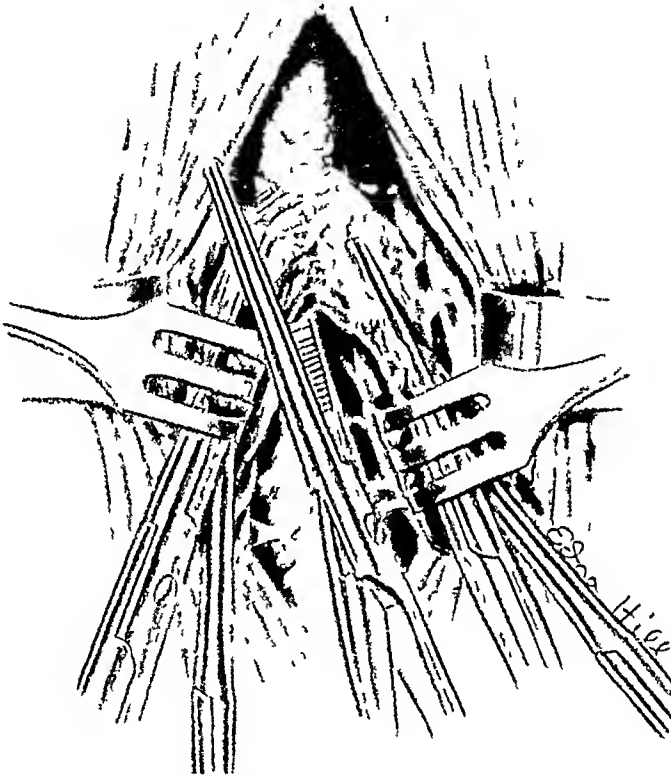


FIG 13—Division of isthmus continued section by section. Only small portion remains.

There are conditions in which this preliminary exposure of the trachea by bisecting the isthmus is not practical. This is notably so in large asymmetrical adenomatous masses with substernal extension and marked displacement of the trachea. The trachea is so far below the surface and often so displaced to one side or the other that its exposure as the initial step of the operation is not feasible. Under these circumstances it is our practise to begin the exposure at the superior pole, gradually to displace the mass downwards and mesialwards, following as our anatomical guide the sheath of the carotid vessels until the substernal extension has been disengaged.

In a large majority of the operations in this clinic the ribbon muscles are bisected on one side. To this there are many advantages, especially if one

recognizes the importance of a dissection of the superior pole into its component structures

We discontinue the gas anæsthesia as soon as the vessels of the superior pole have been tied and at the same time the head is elevated somewhat from its hyperextended position. Both steps are taken for the protection of the recurrent laryngeal nerve. Elevating the head restores to more nearly normal the relation of the trachea, the inferior pole and the nerve. When the anæsthesia is discontinued consciousness is soon restored and the patient will talk or cough on command.

In the next step, mobilization of the inferior pole (which in its conformation is really not a pole as one may speak of the superior pole), the patient is asked to count or cough to give assurance that the recurrent laryngeal nerve is intact. We once believed that this assistance or precaution could be disregarded by the experienced operator. We have changed our minds, and now believe that the more experience the operator has had the more precautions he welcomes.

In this clinic very much more attention is paid to hæmostasis now than in the past and with this we have noticed a much lower percentage of wound complications. The electro coagulating unit is used for control of all minor sources of hæmorrhage. Thus much time is saved, much less ligature material buried in the wound and a much "drier" wound is the result.

The longer and the wider our experience in goitre surgery, the more attention we are paying to minutiae of technic, to the niceties of neat surgical dissections, and to the tidiness of a dry and carefully reconstructed operative field.

DR FREDERICK BOTHE said the only question as to this type of approach to thyroidectomy is the ability to control hæmorrhage as satisfactorily. Not infrequently great difficulty is encountered in controlling hæmorrhage at the junction of the lateral lobes with the trachea. The lateral approach is very satisfactory as the greater part of the blood supply has been controlled before this area is reached.

DR CHARLES F. NASSAU said that the division of the isthmus as the first step in doing partial lobectomy has been used for many years by a number of operators. It is not a new method but it does facilitate the removal of goitre.

DR BENJAMIN LIPSHUTZ said that the operation of thyroidectomy is essentially an anatomical one. He has carefully looked over many dissected thyroid glands with particular reference to the superior and inferior laryngeal nerves. Concerning injury to the superior laryngeal nerve in the ligation of the superior thyroid artery, it is to be borne in mind that the division of the superior laryngeal nerve into its external and internal branches may occur at different levels and it seems safer to ligate the superior thyroid artery close to the upper pole of the gland or better still to include a tiny piece of superior pole in the ligature. Similarly, much variation exists in the anatomy

of the inferior laryngeal nerve, it may pass behind the inferior thyroid artery, in front of it, or it may divide into a number of branches, which embrace the artery. Regarding the division of the isthmus, Richter, of Chicago, has described a technic of thyroidectomy that fulfills the conditions of safety and requires a minimum of ligature material. He utilizes as the initial step of thyroidectomy ligation of both superior thyroid arteries. Guthrie, in 1926, wrote a paper wherein he advised the ligation of both superior thyroid arteries as the initial step in all intrathoracic goitres and in a number of the speaker's cases this procedure facilitated the mobilization of the thyroid gland. Richter also advises the division of the isthmus as an important step in the operative technic of thyroidectomy.

SPINAL ANÆSTHESIA

DR JOHN PAUL NORTH (by invitation) read a paper with the above title

NATURAL FISTULAS BETWEEN THE GALL-BLADDER AND THE COLON

DR THOMAS A. SHALLOW, and, by invitation, DR STERLING MCNAIR, reported the case of a spontaneous biliary fistula existing between the gall-bladder and the hepatic flexure of the transverse colon. The patient was admitted to Jefferson Hospital in June, 1925, when she was fifty-two years of age. She complained of pain in the right upper quadrant of the abdomen in the region of the liver and gall-bladder, but at times she had generalized abdominal pain. She had never had typhoid fever, or other serious illness except indigestion for the past twelve years. Her present illness began in the middle of November, 1931 with sudden sharp abdominal pain, generalized in character but more particularly involving the right upper quadrant. Following the onset of the pain, she vomited large quantities of bile for several days, which was followed by a moderate amount of relief. Two days after the onset of her trouble she became jaundiced. The jaundice was progressive and, at the time of her admission, was marked. Her temperature at the time of admission was 100.4°, pulse 108, respirations, 26, leucocyte count, 23,000, and she was in a stuporous condition.

Physical examination was essentially negative except for the abdomen. There was rigidity in the right upper quadrant, associated with tenderness. The rigidity was limited to this area and not associated with any generalized abdominal disturbance. A diagnosis of cholangitis in a uræmic patient was made and operation not recommended. The patient died two days following admission. Autopsy was limited to the abdomen.

The hepatic flexure of colon and part of the omentum were densely adherent to the liver around the gall-bladder region, forming a distinct mass. The spleen weighed 340 grams and was quite adherent to surrounding structures. The œsophagus and stomach were normal. No lesion was observed in the small intestine. The ascending colon at the hepatic flexure was densely adherent in two places to the fundus of the gall-bladder, causing a distinct kink in the colon. These adhesions were so dense that they had to be separated with a knife. At the site of the adhesions there was an opening where the gall-bladder and colon communicated. The opening was approximately one centimetre in its greatest dimension. The remainder of the colon was normal. The liver was markedly enlarged, very soft, flabby and friable and on section cut with ease. The liver substance in areas seemed to be broken down. The larger bile-ducts were distended with a

dark greenish yellow, purulent material Just beneath the capsule on the left lobe of the liver on the upper surface were several small areas containing pus The gall-bladder was thickened, contracted and did not contain any bile, nor could stones be demonstrated The hepatic duct contained a large stone The common duct, although enlarged, was patent The cystic duct was obliterated and no evidence of a patent communication between the gall-bladder and liver could be demonstrated

DOCTOR SHALLOW remarked that the frequency of biliary fistula from gall-bladder to colon is shown in figures submitted by Roth, Schroeder and Schlott In 10,866 necropsies performed, internal biliary fistula was found forty-three times, of this number nineteen were between gall-bladder and duodenum and sixteen gall-bladder and colon In the ANNALS OF SURGERY 1925, Judd and Burden, of The Mayo Clinic, report 153 cases of internal biliary fistula operated upon Of these 117 were between gall-bladder and duodenum, four between gall-bladder and duodenum and colon, four between gall-bladder and stomach and twenty-six between gall-bladder and colon One hundred and eleven were female, forty-two male, the greatest number were in the sixth decade of life, and the symptoms had been present from one month to forty years, with an average of ten years Most of these patients had symptoms of gall-bladder disease Of these 153 cases, the diagnosis was made negatively in only two, both of which were of the type extending from gall-bladder to colon Of the cases reported where the fistula extended from the gall-bladder to the colon, the most common site was at the hepatic flexure

This case is unusual in that there was no bile in the gall-bladder, nor in the fistulous tract, nor in the colon, and that the cystic duct was obliterated, although the common duct was patent, and, although the patient had symptoms of gall-bladder disease for the past six years, she was fairly well until the three days before admission, when the stone in the hepatic duct lodged so securely that no bile was able to enter the common duct and duodenum

In the literature, the speaker found another interesting case in connection with the above which shows that with an internal biliary fistula between the gall-bladder and duodenum there may be no gastro-intestinal symptoms and that the health may not be impaired to any extent This case is that of a man, aged 81 years, who was admitted to Jefferson Hospital December 16 1931, with frequency of urination, nocturia, dysuria and retention of urine This patient had never had any symptoms relative to gastro-intestinal tract He died after four days and autopsy showed cause of death as Prostatic hypertrophy, Chronic cystitis, Acute suppurative pyelonephritis During the course of the autopsy there was discovered a biliary fistula extending from the gall-bladder to the duodenum the tract was patulous No evidence of gall-bladder disease nor any lesion of stomach was seen

DR DAVON B PREIFFER recalled the case of a woman over seventy years of age upon whom he operated about a year ago who had both a communication between the gall-bladder and colon and gall-bladder and duodenum She had a long-standing history of gall-bladder indigestion After repair of both fistulae and a cholecystectomy she made a good recovery

DOCTOR SHALLOW said that the autopsy showed a fistulous tract between the gall-bladder and the transverse colon The cystic duct was entirely obliterated There was a stone in the hepatic duct We all know the serious-

ness of anastomosis between the gall-bladder and the transverse colon because of the almost certain result of ascending infection into the ducts of the liver. But in this case, Nature was able to combat by blocking in the cystic duct, the ascending infection. This woman died of cholangitis, secondary to a stone in the hepatic duct.

The time of the anastomosis can be definitely placed as six years before her death. At that time she was employed in one of our large hospitals and was under the care of some of the best men in this city. The diagnosis made at that time was carcinoma of the liver. This was based on the presence of a mass, assumed to be an enlarged liver, without any of the manifestations of gall-bladder disease. Contrary to the natural fistula formed between the gall-bladder, stomach or duodenum, which is fairly common, the anastomosis between the gall-bladder and transverse colon is relatively infrequent.

STATED MEETING HELD OCTOBER 2, 1933

The Vice-President, DR. WALTER E. LEE, in the Chair

CALVIN M. SMYTH, JR., M.D., Recorder

ABDOMINAL ANEURISM

DR. HUBLEY R. OWEN reported a case of extensive abdominal aneurism, extending from below the diaphragm to the bifurcation of the iliacs, in whom, treatment by ligation or the use of a metal or fascial band being impossible, the aneurism was treated by wiring. The man, aged forty-eight years, was admitted to the Philadelphia General Hospital April 1, 1933, on account of abdominal pain. His personal and family history were essentially negative and in no way suggestive of lues.

In the abdomen extending from the upper left epigastrium down toward the course of the aorta to the left lower quadrant there was a large mass, which practically filled the middle third of the abdomen. An expansible pulsation was present over this mass and a bruit was heard on auscultation.

He remained in the hospital ten days, when he was discharged because surgical intervention seemed inadvisable. Eight days later he was re-admitted because of continued abdominal pain, increasing in character. X-ray April 3, 1933, as follows: "There is a large somewhat circumscribed dense shadow in the abdomen, extending from the second to the lower margin of the fourth lumbar vertebra, extending more to the left. Fluoroscopically, it was very difficult to visualize any pulsation in the mass. In the lateral view there appears to be a somewhat smooth concavity of the second and third lumbar vertebrae. The remaining vertebrae appear normal. Heart is enlarged in its transverse diameter. Hypertrophy of the left ventricle. Widening of the arch of the aorta. Lung fields normal."

Laboratory examinations were essentially negative.

Operation—Under ether anesthesia, a right rectus incision was made from the ensiform cartilage to the umbilicus. The intestines were packed to the side, exposing a large thick-walled saccular type aneurism extending from the diaphragm to the bifurcation of the iliacs. The mass measured

PEPTIC ULCER RUPTURING

six inches long by three inches wide. The right iliac could be traced making its exit from the lowermost portion of the aneurism. The left iliac also made its exit more posteriorly but could not be felt in close proximity to the tumor. The thinnest portion of the sac was at its lower pole. Expansible pulsation was marked. The transverse colon was attached to the mass above. Ten cubic centimetres of blood were aspirated with a small Luer syringe. A cannula was inserted into the mass and blood was ejected in spurts. Gold wire to the extent of six feet was inserted into the aneurism and an electric current passed through the wire for a period of forty-five minutes, the current ranging from a minimum of five milliamperes to a maximum of forty-five milliamperes. Cannula was withdrawn. Bleeding readily checked by pressure and abdomen closed.

April 22, 1933 the systolic blood-pressure was 122 diastolic 84. The patient made an uneventful recovery from his operation and was discharged May 10, 1933.

He was returned to the care of his family physician until September 7, 1933, when he reported for observation. On that date his condition was much improved. He had gained $10\frac{1}{2}$ pounds in weight and had had very little discomfort from abdominal pain. An X-ray examination made September 8, 1933, showed approximately eight or ten loops of wire lying in front of the lumbar vertebræ and extending from second to fourth inclusive. No part of aneurismal sac is demonstrable by fluoroscopical examination, although on the film it appears to extend to left slightly beyond border of left iliopsoas muscle line. There is apparently no change in the erosion of anterior surface of bodies of third and fourth lumbar vertebræ.

During his convalescence he has been taking large doses of potassium iodide. If his symptoms return it is expected to repeat the procedure of wiring.

PEPTIC ULCER RUPTURING THROUGH CARDIO-ŒSOPHAGEAL JUNCTION INTO PLEURAL CAVITY

DR IRVIN E. DEIBERT reported the case history of a man aged fifty-three who was admitted to Cooper Hospital in the service of the reporter January 19, 1933, complaining of severe epigastric pain. Upon admission he was somewhat stuporous, pulse very rapid and thready, respirations thirty-eight per minute, temperature 100° . His face was somewhat cyanotic, expressive of severe pain, left chest tympanitic, breath sounds somewhat distant, heart sounds very rapid and weak. The abdomen was slightly distended but very rigid over the entire epigastric area. The extremities were somewhat cyanotic. Otherwise the examination was negative. The diagnosis of perforated ulcer was made and operation deferred with the thought that the patient might possibly react to supportive treatment, however his condition became rapidly worse and he died eight hours after admission. An autopsy was done with the following conditions revealed:

The abdomen when opened was apparently normal with the organs *in situ*. The thorax when opened had a decided fecal odor and a large quantity of dark brown fluid was observed in the left chest. Fifty-two ounces of this fluid were removed and it was then found to be seeping from a perforation in the peri-œsophageal tissues about 1½ inches above the diaphragm. The œsophagus and stomach were removed together and section of the stomach revealed a large ulcer at the cardiac opening on the stomach, not in œsophageal tissue.

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The heart, pericardium injected apparently from external irritation, fatty, slightly enlarged, vegetations on the mitral, aortic and tri-cuspid cusps

Aside from an enlarged adherent thickened gall-bladder which contained several large stones, the remainder of the examination was about that of the average individual of this type and age

The past history of this patient is as follows. He was always a very healthy individual, no serious illnesses or operations. About a year and a half ago he began to complain of digestive disturbances and was studied with the thought that he was suffering from gall-bladder disease. X-ray studies at that time were negative as to gall-bladder disease or ulcer. These films have been reviewed since the death of the patient and with our present knowledge show nothing in the examination to make one suspect any pathological condition of the gastro-intestinal tract.

The patient's health following the gastro-intestinal study was reported to have been good up to three weeks ago, when he developed an attack of influenza. He was apparently convalescing when a sudden attack of pain occurred about an hour and a half before admission to the hospital.

A study of the literature covering ruptured peptic ulcer has been made and the reporter is unable to find other than one case of this type reported, this was by H. Von Schwartz, Germany, *Med. Klinics*, 1932. His case was in many respects similar to this.

THYROIDECTOMY IN THE PRESENCE OF COMPLETE BRANCH BUNDLE BLOCK

DR. FREDRICK A. BOTHE reported the case of a woman, fifty-three years of age, who was admitted to the Presbyterian Hospital, September 12, 1929, with the chief complaint of loss of weight, tachycardia, nervousness and fatigue. She was perfectly well until January 6, 1929, when she had a slight attack of influenza accompanied by fatigue, general listlessness, and headache. She was confined to her home for two days, but the fatigue and general listlessness persisted. Ten days later she began to be nervous and the ankles swelled. Subsequently she developed bronchitis and was confined to bed for two weeks. After recovering from this illness she noted that her heart beat very rapidly, and she was very short of breath. In the meantime, the nervousness had become progressively worse. In June, 1929, palpitation developed and she was always fatigued. The above symptoms gradually became more severe, accompanied by a progressive loss of weight, and she was practically confined to bed before admission to the hospital.

When admitted, the essential physical findings were: a moderate loss of weight, nervous, restless, and very active mentally, pulse 120 and regular, the eyes showed slight widening of both palpebral fissures, Stellwag's and von Graefe's signs negative, ocular movements normal, thyroid gland moderately enlarged in the isthmus and right lobe, irregularly nodular and fairly firm. There was a visible pulsation of the right external jugular vein, with a pulsating systolic thrill. No bruit was heard over the thyroid gland, a systolic murmur was transmitted to the vessels of the neck. There was a visible pulsation in the second interspace on each side of the sternum. The heart beat was forcible but no thrill could be palpated. To percussion there was slight enlargement. A rough pre-systolic murmur could be heard at the apex which was transmitted to the axilla. A soft blowing murmur

BILATERAL PULSATING EXOPHTHALMOS

was heard at the xyphoid. The basal metabolic rate was plus 48. A teleorontgenogram showed moderate enlargement of the heart. An electrocardiogram showed a partial right bundle branch block. The blood Wassermann was negative. There were no other laboratory findings of any significance. *Diagnosis*—Toxic adenoma of the thyroid with partial right bundle branch block.

The patient was given the usual pre-operative treatment for toxic adenoma. One week after admission the basal metabolic rate had fallen to plus 33. She improved clinically but did not become stabilized until twenty days after admission. At this time the basal metabolic rate was plus 3. A second electrocardiogram showed a complete bundle branch block. In view of the stabilized condition of the patient and believing that the toxic adenoma was responsible for the progressive myocardial changes a thyroidectomy was performed under novocaine anaesthesia. The patient stood the operation well and reacted favorably. On the fifth post-operative day the pulse was down to 80. The convalescence was somewhat prolonged but uneventful. She was discharged from the hospital twenty-two days after operation. A number of electrocardiograms were made subsequent to operation which demonstrate the disappearance of the branch bundle block. The improvement which they show immediately after operation illustrates how favorably the damaged myocardium may react subsequent to thyroidectomy. All evidence of failing compensation disappeared, the patient's strength gradually improved and she promptly returned to her normal weight. It is now four years since the operation and there has been no evidence of failing cardiac compensation. The pulse rate is normal (80) and the patient is able to do clerical work. The dyspnoea has entirely disappeared with the exception of two occasions when she was walking on the street against a very strong wind. Both times she developed cardiac embarrassments and was confined to bed for several days. She is able to indulge in moderate exercise with no bad effect.

Electrocardiographical studies made before and after operation illustrate both the untoward effect a toxic adenoma has upon the myocardium, and the improved condition of the myocardium subsequent to thyroidectomy.

BILATERAL PULSATING EXOPHTHALMOS

DR FREDRICK A. BOTHE reported the case of a woman sixty years of age who was admitted to the Presbyterian Hospital January 24, 1933, with the chief complaint of frontal and occipital headache and swollen and protruding eyes. The patient was perfectly well until three days before admission when she fell down stairs striking the back of her head and left shoulder. A large lump developed on the back of the head and there was slight bleeding from the left nostril which she thought came from the back of her throat. No drainage occurred from the ears. She was dazed but not unconscious. In twenty-four hours she began to notice the eyes becoming more prominent and she developed severe conjunctivitis with chemosis of both lower lids. At the same time she began to suffer from frontal and occipital headaches. These conditions became progressively worse. Twenty-four hours before admission she noticed a roaring sound in the head, which was situated above the left ear. A gradual failing of vision developed, more marked in the right than in the left eye. Nausea and vomiting occurred twenty-four hours before admission.

When admitted she complained of a roaring noise in her head, and a severe headache. There was large hæmatoma over the left parietal region, and a distinct depression could be palpated at its borders. On auscultation over the cranium a definite bruit could be heard over both temporal regions and the mid-portion of the forehead. It was heard best over the left temporal area. The pulsation of the left carotid artery was controlled by compression with the thumb over the transverse process of the sixth cervical vertebra, but this did not completely obliterate the bruit. Compression of the right common carotid pulsation did not diminish the bruit at all. X-ray of the skull was negative for fracture. Examination of the eyes showed bilateral exophthalmos of moderate degree accompanied by pulsation. Right lid ptosed and could not be raised. Conjunctivæ very injected and protruding between the lids. There was very slight outward rotation, and hardly noticeable upward or downward movement, and no inward rotation. No involvement of conjunctive, no inward or outward rotation, but slight upward and downward motion. The pupils are equal and respond well to light. Ophthalmoscopic examination showed media clear in both eyes, discs normal in color and outline. Arteries bright and somewhat irregular. There is a pronounced bruit, synchronous with the pulse, which is heard over each eye, louder over the right, suggesting arteriovenous communication between the internal carotid artery and the cavernous sinus. An examination of the heart revealed no enlargement, the sounds were of poor quality but the rhythm regular.

The chemosis of the lids became progressively worse, that of the right being extreme. The headache and disturbance from the bruit became more pronounced. Ten days after admission the conjunctivitis and chemosis of the lids progressed to such an extent it was very difficult and painful to open them. The audibility of the bruit remained the same as noted above. Fifteen days after admission compression of the left common carotid artery was started, the pulsation being compressed about one minute. By this time the chemosis of the left eyelid had increased considerably. Daily compression was practiced, carefully observing for any sensory or motor changes on the opposite side of the body, and obliteration of the bruit. The length of compression was gradually increased until it could be continued for thirty minutes without any untoward development.

Six weeks after admission, the patient was operated upon under local anæsthesia. The left common carotid artery and its bifurcation into the internal and external carotid arteries were exposed. To obtain a good exposure it was necessary to ligate and cut the superior thyroid artery. Clamps were placed on the common, external, and internal carotid arteries and the blood expressed between the clamps. The clamp on the internal carotid artery was released and blood flowed into the obliterated space between the clamps. The blood was then expressed from the space between the clamps and the clamp was then reapplied on the internal carotid artery. A similar procedure was carried out with the clamps on the external and common carotid arteries. The only time the bruit was completely obliterated was when the common carotid was clamped. As soon as the clamp was loosened on this artery the bruit returned. The blood-pressure was being taken in the course of the operation. When the bruit was obliterated there was no fall in blood-pressure, and no motor or sensory changes occurred on the opposite side of the body. The clamp was left on the common carotid artery, a ligature carried beneath the artery but not tied. The wound was

left wide open and a loose dressing applied. The patient was carefully observed for eight hours for any evidence of change in the blood-pressure or signs of motor or sensory changes on the opposite side of the body. During this time the patient did not hear the bruit and it could not be heard by auscultation. She was then taken to the operating room again and the double ligature was tied tightly around the common carotid artery and the wound was closed with one piece of gauze for drainage. The clamp was left *in situ* for eight hours before ligating the vessel as it could easily be removed had the patient developed any evidence of cerebral softening. This type of operation was developed by Dr. George M. Dorrance and it was at his suggestion that the reporter used it. The patient thought she faintly heard the bruit on several occasions during the first few weeks after operation but has not heard it since. At the time of the operation she was only able to distinguish light from dark in the right eye, the vision in the left eye was impaired about 40 per cent. Subsequent to operation the oedema of the lids, conjunctiva and chemosis slowly improved and the ocular movements likewise returned. At the same time there was a gradual improvement in the vision of both eyes.

Four months after operation, there was slight chemosis of the right lower lid which has been present for four days prior to that time. She stated that the condition of the conjunctiva was practically normal. The vision in her left eye was almost normal and that of her right eye had improved about 70 per cent and was still improving. She had developed several corneal ulcers in the left eye during convalescence.

DR. GEORGE M. DORRANCE said that he had seen this case with Dr. Bothe who ligated the superior thyroid and the common carotid artery. Approximately 50 per cent of the gross reflux from the external carotid comes through the superior thyroid artery. In this operation the speaker ligates the common carotid, several days or a week later, he ligates as many of the branches of the external carotid as necessary to make the bruit disappear. In most cases, it is essential to ligate the common carotid artery, the superior thyroid and as many other branches as necessary to cut down the volume reaching the internal carotid. One important point is that in ligating these arteries it is wise to drain the wound in the presence of gross mouth or nose and throat infection. We were taught not to do it but most of the surgeons in the World War found that if one ligated the external carotid for a hæmorrhage in the mouth, and failed to drain, infection frequently occurred and following this secondary hæmorrhage from the ligation wound.

DR. THOMAS A. SHALLOW said that he has proved conclusively in a case which is on record that after the ligation of the common carotid artery pulsating exophthalmos is not cured in all cases. The reason for this is not, as Doctor Dorrance intimates, the establishment of a collateral circulation by the superior thyroid arteries, but it is due to a reversal of the flow of blood along the common carotid artery from the circle of Willis down to the point of ligation.

DR GEORGE M DORRANCE rejoined that the first time he ligated the common carotid artery the bruit did not disappear. Later he ligated the branches of the external carotid up to the internal maxillary and the bruit did disappear. It has been shown that if one excises the carotid bulb, then sutures the cut ends of the external and internal carotid together, the circulation will flow from the external into the internal. This phenomenon of the flow of the blood down the external carotid into the internal carotid after ligation of the common carotid has been observed by many others, including Matas, so there can not be much doubt of the truth of the observation.

SUPERIOR LARYNGEAL NERVE AND THE SUPERIOR POLE IN THYROIDECTOMIES

DR WILLIAM H ERB, by invitation, read a paper with the above title.

DR CHARLES FRAZIER said that by preventing accumulation of mucus in the trachea patients have been more comfortable. In evidence he called attention to the fact that three years ago he purchased a half-dozen special atomizers for use in the goitre ward. The atomizers are not there any more! That seems to be proof positive that the mucus has disappeared. If one looks at the specimen it will be seen how intimate are the branches of the superior laryngeal nerve with the superior thyroid artery. Prior to the adoption of the present technic a hæmostat was passed under the whole pole and the blades sufficiently separated to put on two larger hæmostats and divide the pole between them. It is now known that it is absolutely impossible to make a mass ligature of the superior pole without injuring the external branch and possibly the internal branch.

ETIOLOGY OF INDIRECT INGUINAL HERNIA

DR MAXWELL CHERNER (by invitation) read a paper with the above title for which see p. 577.

DR BENJAMIN LIPSCHUTZ remarked that this study represents the continued observations of many years. It is not merely based on dissections of fifty consecutive cadavers. Observing the numerous anatomical variations year in and year out led to a more intensive survey of their relative frequency. Similar results follow the careful study of any anatomical structure. There is an ideal anatomy, but there is no ideal body. Departures from normal are constantly encountered. This study is here presented purely from an anatomist's viewpoint, and is not meant to have any clinical application. It applies probably with the same degree of accuracy to the direct, as well as to the indirect hernias, for a direct hernia is essentially a blowout of the tissues. Some years ago the speaker was interested in the muscle variations of the inguinal region and began such a study on

a number of old, well-defined hernias. In very old hernias the inguinal canal is largely obliterated, since the internal and external abdominal rings tend to approximate each other. Thus no conclusion can be drawn from evidence obtained in large, well-defined hernias. The study must be carried out mainly on the very early types of hernias and the muscle variations compared with similar observations on cadavers free from any signs of hernia. In the present state of this study, it will be wiser not to attempt to draw any practical conclusions concerning its relation to the operative repair of the different types of inguinal hernia.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD OCTOBER 11, 1933

The President, DR ALLEN O WHIPPLE, in the Chair

VALUE OF MULTIPLE DRILL HOLES IN THE TREATMENT OF NON-UNION OF FRACTURED FEMUR

DR JOHN V BOHRER presented a boy who was admitted to the children's surgical service, Bellevue Hospital, August 29, 1931, with a history of an automobile accident September 11, 1930, in which he sustained a fracture at the junction of the middle and upper thirds of his right femur. He had been admitted to a hospital and operated upon for his fracture. This resulted in non-union. Apparently there was no fixation of the fragments in this operation, but there was end-to-end approximation.

When admitted to Bellevue Hospital he was a well-developed boy of nine years, normal in all respects except the deformity of his right leg. The right femur was sharply angulated at the junction of its upper and middle thirds. There seemed to be fibrous union. His right leg was two inches shorter than his left. The diameter of the right thigh was three-fourths inch less than the left. The angulation was such that the foot could not be placed on the floor in a weight-bearing position. There was no nerve injury. He had a five-inch linear scar on the lateral aspect of his right thigh at the level of his fracture. The thigh had the appearance of a bow with the hamstring muscles forming the string. These were markedly foreshortened and atrophic.

X-ray examination revealed an incompletely united fracture at the junction of the middle and upper thirds of the right femur. The fractured ends were in apposition but there was a marked anterior angulation. At the site of the fracture there was sclerosis of the bone, callus formation on the posterior surface, and no bony union. An effort was made to stretch the foreshortened hamstring muscles. A Buck's extension was applied to the lower leg and the thigh muscles were given daily baking and massage for one week. He was then operated upon for reduction of the deformity and a sliding bone graft was done to maintain the reduced position and promote bony union. It was necessary to use screw traction on a Hawley table to overcome the deformity and stretch the taut hamstring muscles.

The previous incision was reopened, the femur exposed, the fibrous union divided and the eburnated ends of the bone cut away in order to secure healthy bone approximation. Using a Moorehead circular saw, a typical sliding bone graft was done. A Buck's extension was applied in order to prevent recurrence of the contraction of the hamstring muscles and a plaster spica was applied for complete immobilization. The patient was given an immediate transfusion of blood and was returned to the ward in fair condition. X-ray two days later demonstrated the fragments in excellent position. The angulation had been entirely reduced. His convalescence was uneventful. He was given a diet rich in calcium and vitamins, to promote the formation of callus. An x-ray taken nine weeks later demonstrated a slight recurrence of the former angulation and a beginning absorption of the bone graft. More weight was then added to the Buck's extension, which had been applied under

the spica bandage. This seemed to prevent further development of the deformity. At the end of twelve weeks the case was removed. An x-ray picture definitely showed that the graft was being rapidly absorbed and, in spite of the extension, the deformity was recurring. Again there was only fibrous union. Due to the location of this fracture it was impossible to apply a walking plaster casing, so, as a substitute for the stimulation obtained from such a procedure, a Mummensen's apparatus, which has been used in this country by Dr. Arthur Krida with good results, was tried. A spica case was applied and the apparatus placed so the trip mallet struck the padded heel of the patient. This simulated the jar of walking but did not stimulate bony union. Four months after the bone-graft operation and subsequent treatment there was still no bony union. Multiple drill holes were then decided upon and the original wound, which had healed by primary union, was partially reopened over the line of the fracture. Twelve 3/16 inch drill holes were made in a criss-cross fashion about the fracture line and a spica case again applied with a Buck's extension on the leg to prevent contraction of the muscles. This casing was removed in three months, bony union had taken place. There was no shortening. At the present time the x-ray still shows slight angulation. His functional result is perfect.

DR. FENWICK BEEKMAN remarked that in 200 to 300 cases of fractured femur in children he had seen only one or two cases that were ununited and in both the reason was because of the presence of muscle between the fragments. In this case the reduction at the hospital had been complete and the non-union was due to other than mechanical causes. A second point of interest, from the view of the final outcome, was that the cause was large deposits of scar tissue about the site with a certain amount of ischaemia. The treatment by which union was secured, through boring holes in the bones, proves this point. The speaker said he had been interested in the work of Leiche and Policaid, who recommended the boring of holes in the bones in bone transplants. If the holes are made in the transplant it gives more room for the entry of blood-vessels. In this case the non-union was due to sclerosis of the vessels in the soft tissue about the fragments and by means of the holes vascularity was increased.

TORSION OF THE OMENTUM

DOCTOR BOHRER presented a man who was admitted to the Peekskill Hospital, service of Dr. William Maitens, February 29, 1932. For two days previous to his admission he had suffered from progressively increasing pain in his abdomen. At first it was a mere discomfort, then generalized abdominal pain which ultimately localized in the right lower quadrant, more acute just below and lateral to the umbilicus. He had never experienced a similar attack. There was no vomiting. His one complaint was pain which was aggravated by being in the erect position.

He suffered from habitual constipation and frequently took Epsom salts but had not taken any cathartic for one week before the onset of pain, and took none at that time. He never was athletic and did not indulge in setting-up exercises. The speaker had operated upon him in 1930 for an oesophageal diverticulum. There had been no other illnesses. He had had a right inguinal hernia for fifteen years and had always worn a well-fitting truss. When in the erect position, without a truss, abdominal contents entered the hernial sac but never became incarcerated, and the hernia always spontaneously reduced when in the recumbent position. Frequently the truss

would become displaced and the hernia protruded, this the patient would reduce by taxis, while in the erect position. He was sixty-eight years old, in fair nutrition but acutely ill. He was not fat and did not have a protuberant abdomen. His general examination was normal except for the surgical condition. His pulse was 96 per minute and temperature 100.5° F. The abdomen was slightly distended. Abdominal breathing was very limited. There was only slight rigidity but marked tenderness in the right lower quadrant, especially below and just lateral to the umbilicus, no palpable mass, moderate tympany, no signs of fluid, on auscultation the entire abdomen was silent. The hernial sac was empty. Blood count was Hæmoglobin, 85 per cent, red blood-cells, 4,740,000, white blood-cells, 13,700, with 85 per cent polymorphonuclears. Urine analysis showed a trace of albumen, no sugar, a few white and red blood-cells.

Operation under spinal anæsthesia disclosed a slight amount of free amber fluid, a normal appendix, an empty right hernial sac and a portion of the right half of the great omentum gangrenous. This gangrenous portion of omentum was attached only by a two-inch pedicle consisting of a medium-sized vein and artery. There were seven clockwise turns of the pedicle. The pedicle was untwisted, clamped, ligated and divided, and the mass removed. The appendix was removed. The abdominal wound was closed in layers without drainage. The hernia was then repaired by the Bassini procedure. The patient made an uneventful recovery except for an acute exacerbation of his chronic bronchitis. This caused a distressing cough which resulted in a weakness of his abdominal wound, but had no apparent effect on his herniorrhaphy. He has remained well and is free of pain. The specimen consisted of a piece of omentum measuring approximately ten by five by one centimetres. The distal one-half of the specimen was blackened and discolored, on section it was homogeneous and black in appearance. The proximal one-half contained some gray streaks and showed a few thrombosed vessels.

Microscopical examination of material removed from the distal portion of the specimen showed marked congestion of arteries, veins and capillaries. There are numerous small hæmorrhages throughout the lobules which separate the fat cells. A section from the proximal portion showed a similar picture with a few areas of fat necrosis and saponification.

DR JOHN H. MORRIS said that recently a large number of these cases had appeared in the literature, suggesting that they may have been overlooked in the past and that the older statistics on this subject are not entirely trustworthy. A large percentage of the reported cases have appeared in the last few years. As to classification, these cases may be simply grouped as (1) torsion associated with hernia. Doctor Bohrer's case falls in this group. The herniæ themselves have certain destructive characteristics. They are scrotal in type, invariably contain omentum, are easily reducible and show statistically an average duration of sixteen years before onset of acute attack of torsion. Most of these cases have worn trusses which may be a predisposing factor. An interesting mechanism has been described to explain how torsion of the omentum is initiated. It has been suggested that the omental content of these scrotal herniæ becomes molded by its long residence in the inguinal canal, so that eventually there is formed a long thin pedicle corresponding to the inguinal canal and a relatively large bulbous extremity corresponding to the scrotum. Repeated attempts at reduction of this mass are said to be responsible for the initiating twist which leads to complete torsion.

This mechanism is held to be analogous to the rotation of the fetal head in the parturient canal. The rotation produced is dependent upon the attempts of the relatively large mass to adjust itself to varying diameters of the inguinal canal.

Torsion associated with hernia is the most common type observed and the omental masses produced are often displaced into the abdomen where they may undergo complete torsion. In these instances the related hernia is held to be the initial etiological factor. It is difficult to differentiate torsion of the omentum which has taken place in the inguinal canal from strangulated hernia. In the latter, however, an obvious point of constriction is apparent, possibly at the internal or external ring. In the former there is no such point of constriction since the circulatory disturbance has been produced by the actual contortions in the neck of the omental mass itself. It is important to make this differentiation since in cases of scrotal torsion, the omental turns may "run up" the pedicle into the abdomen where secondary torsion and gangrene of the omentum may occur. This is the so-called combined type of torsion which requires laparotomy in addition to the treatment of the inguinal canal pathology.

The types of torsion occurring independently of hernia are induced by some type of intra-abdominal pathology such as tumors or cysts occurring in the omentum and acute inflammatory disease which induces adhesion or inflammatory thickening of a portion of the omentum. There is also recognized a traumatic variety in which torsion follows blows on the abdomen or violent muscular effort such as wrestling.

LUDWIG'S ANGINA

DR RALPH COLP presented a boy, aged ten, who was admitted to Mount Sinai Hospital April 18, 1932. One week before admission he had developed a swelling of the submental nodes which was progressive. His temperature ranged between 101° and 103° , and he experienced difficulty in opening his mouth and swallowing. When admitted to the hospital he had a temperature of 102.4° , pulse 128, and respirations of 24. He was acutely ill. In the submental region was a swelling which was hard and non-fluctuating, the overlying skin was brawny and oedematous, the mouth was opened with difficulty, the tongue was definitely elevated and fixed and there was some oedema about the frenum but the lateral areas of the floor of the mouth and the submaxillary areas were comparatively free.

The mass was poulticed for twenty-four hours without effect. Then, under general anæsthesia of gas and oxygen, a transverse skin incision was made between the mandible and hyoid, the mylohyoids were separated in the median raphe and a mass of necrotic lymph-glands were extirpated but no pus encountered.

Following the operation the patient did not do well. He became more toxic. The trismus increased and upon forcing the jaws open, the floor of the mouth was markedly oedematous. The submental induration had spread in twenty-four hours to both submaxillary triangles and these were stony hard, the overlying skin being brawny and oedematous. His respirations were stertorous and labored. The condition now resembled a spreading phlegmon of the floor of the mouth, a Ludwig's angina. Radical extirpation of the submaxillary salivary glands to establish drainage was decided.

upon It was felt that inhalation anæsthesia, because of the beginning œdema of the glottis, was unwise, and because of the age of the patient, a boy of ten, extirpation of the salivary glands under local did not seem feasible Accordingly avertin was given by rectum while the boy was on the operating table Within three minutes after its administration, the boy became unconscious, markedly cyanotic and ceased to breathe although the pulse remained fair in quality A low emergency tracheotomy was performed with immediate relief of symptoms and during the subsequent operative procedure, oxygen was introduced through the tracheotomy tube

The original transverse incision was prolonged laterally down toward the region of the hyoid bone and then up to the angle of the jaw Upon incising the cervical fascia, the submaxillary salivary glands bulged into the wound The glands themselves were normal but posterior to them, extending along the mylohyoid, the submaxillary and retromandibular spaces, was thin serous yellow pus The submaxillary salivary glands were excised and the wounds packed with iodoform gauze

Following operation, his temperature reached 106° , pulse 146, and his condition was desperate, but a continuous intravenous of glucose and sponging did much to improve him Twenty-four hours later his condition was markedly better He was able to swallow more easily, could open his mouth and the œdema of the floor of the mouth began to subside Within a week his tracheotomy tube was removed, and at the end of ten days his packings He was discharged on the twelfth post-operative day

This patient was presented to point out the risk of using avertin anæsthesia in cases in which the laryngeal glottidis has been encroached upon as in an œdema of the glottis While the narrowed laryngeal opening was sufficient to maintain respiration when the boy was conscious, as soon as deep anæsthesia was obtained, the muscles attached to the larynx became relaxed and asphyxia occurred necessitating tracheotomy In the final analysis, the only safe anæsthesia in this type of case is local infiltration, and it should be attempted even in children if the occasion demands

A second point was to emphasize the inadequacy of the so-called DeLorme median incision to adequately drain deep infections of the floor of the mouth Presumably the process was localized submentally, and although a median incision seemed to drain the focus, progressive suppuration took place, spreading along established fascial planes This was stemmed only when sufficient drainage was secured by bilateral excision of the submaxillary salivary glands

DR PERCY KLINGENSTEIN said that there were also types of deep cervical suppurations not included in Doctor Colp's presentation, particularly those resulting from foreign-body perforations of the upper digestive tract, infected malignant lymph-nodes of the neck, or from parapharyngeal abscess as the result of deep lymph-node suppuration He believed that Doctor Colp was right in stressing the relation of the deep cervical fascia to suppuration in and around the submaxillary gland The speaker mentioned the surgical significance of another space, the mylohyoid space, which may harbor infection This had been brought to his attention after watching Doctor Moschcowitz operate upon just such a case as Doctor Colp had presented this evening After an extensive dissection no pus was encountered until the posterior margin of the mylohyoid muscle was split It was remarkable how toxic these patients quickly became The speaker had occasion to operate upon a case recently just ten hours after a canine tooth was extracted Prostration and evidence of severe constitutional reaction were outstanding

DR FENWICK BEEKMAN said that some years ago the late Dr Astley Ashhurst, of Philadelphia, wrote a very scholarly article on Ludwig's angina, in which he described the anatomy in detail. He believed the lymphatics were not involved and that it was a true cellulitis—a phlegmon without the formation of pus. The technic of operating upon these cases was by means of incisions and the placing of drains which ran into the mouth in front of the angles of the jaw and behind the symphysis. The speaker had used this method in three cases with success. Doctor Ashhurst believed the asphyxia in these cases was mechanical, due to the tongue being pushed back, and he believed in early tracheotomy.

DR ALLEN O WHIPPLE stated that using small incisions with probing of the planes and spaces for finding pus carried with it great danger in uninvolved planes and spaces being contaminated where drainage was inadequately established. For this reason he believed that carefully and accurately placed incisions with the spaces and planes in the neck properly exposed gave much more certainty of finding pus and a much more accurate drainage of the spaces involved with freedom from contamination of uninvolved spaces and planes.

DR HENRY F GRAHAM said that Ashhurst had emphasized the fact that these infections of the floor of the mouth are dangerous, the mortality being 33 1/3 per cent. The speaker had had two of these cases, after reading Ashhurst's article, and as they both got well, regarded him as too pessimistic, but he decided after the third case that he was right, for the third case died.

In closing the discussion, Doctor Colp said that Doctor Klingenstein's point of dividing the mylohyoid muscle was an excellent one and that he was in the habit of doing this identical procedure in almost all excisions of the submaxillary gland, especially if the uncinate process was a large one. The reason that tracheotomy was done in this case was not because of the dyspnea occasioned directly by the disease, but was due to the closure of the glottis due to the avertin anesthesia. As a matter of fact, since the removal of the submaxillary salivary gland in conditions of Ludwig's Angina, the relief of edema of the glottis has been so immediate that tracheotomy has practically become unnecessary.

He remembered reading Doctor Ashhurst's paper in which no mention was made of the procedure recommended by the author. While it is true that some of these cases unquestionably do well when drained by "through-and-through" drainage, it seems poor practice to drain through the infected areas of the mouth when drainage through the neck properly performed will give excellent results.

In answer to Doctor Hanford, the retromandibular space while potential is bounded anteriorly by the posterior margin of the ramus of the inferior maxilla, and the pterygoid process, posteriorly, by the mastoid process and the transverse processes of the atlas and axis, and superiorly by the petrous portion of the temporal bone and the cartilaginous part of the external auditory meatus. The soft parts which upholster this region are anteriorly the

superior constrictor of the pharynx, the internal pterygoid muscle, inferiorly the sternomastoid muscle and the posterior belly of the digastric which separates it from the superior carotid triangle

SUBPHRENIC BILIARY ABSCESS INCISION AND DRAINAGE OF ABSCESS CHOLECYSTECTOMY

DOCTOR COLP presented a woman, aged forty-six, who was admitted to Mount Sinai Hospital February 20, 1933. Six years before admission, she had a left nephrectomy for a probable calculus pyonephrosis, and at the same time calculi were also discovered by x-ray in her right kidney. From then on patient was perfectly well until six months before admission when she developed episodes of pain around the region of the umbilicus, associated with epigastric fullness, relieved by vomiting. The pain finally shifted to the right lower quadrant and after twenty hours disappeared. With this attack there were no chills, fever, jaundice or acholic stools. Three months prior to admission, she experienced a similar attack of pain which was associated with vomiting. Within four days she was better. Four weeks before admission she had a third attack, but with this episode the pain radiated to the scapula. Since this last attack she had a dull pain intermittent in character. Upon admission she appeared chronically ill. There was dullness at the right base of the chest with greatly diminished breath sounds. The liver edge was distinctly palpable one finger below the costal margin and beneath this there appeared to be a tender gall-bladder. There was a left nephrectomy scar. The hæmoglobin was 85 per cent, white blood-cells, 14,400, 85 per cent polymorphonuclears, blood-pressure, 120/80. The urine showed albumin, a few white blood-cells, but no trace of bile or urobilin. The blood chemistry was normal and the blood Wassermann negative. Examination of the chest by x-ray revealed elevation of the right diaphragm which was about two interspaces higher than the left. The gall-bladder failed to visualize after the administration of the dye. There was no evidence of urinary calculi but it was noted that the third lumbar was widened laterally and possessed a coarsening of the trabeculae. There was also some general mottling about this vertebra. A pneumo-peritoneum showed a large amount of air in a left subphrenic space which outlined the spleen and adhesions to the abdominal parietes. On the right side, no air was seen below the diaphragm and when the patient was placed in the lateral recumbent position, no air was seen above the margin of the liver. Investigation of the right kidney revealed normal function.

Under local anæsthesia about four inches of the right eleventh rib was excised from the paravertebral line to the posterior axillary line. The pleura and diaphragm were sutured together above and below the line of proposed incision. Upon incising the diaphragm, about a gallon of bile with a mucopurulent quality escaped. The under surface of the diaphragm was covered with hillocks of granulations and the upper surface of the liver appeared normal. The source from which the bile originated could not be ascertained. Culture of the bile grew *B. coli*. The patient ran a smooth post-operative course and drained a moderate amount of bile. Gradually the sinus contracted down to about a half inch and two weeks before discharge, a sodium iodide injection of the sinus showed a large irregular cavity situated high up, probably under the diaphragm. During the last few days of her stay in the hospital, she experienced epigastric pain with radiation to the right upper quadrant associated with vomiting. Her temperature at this time was 102°. It was felt she had another attack of cholecystitis but operation at the time was not advisable and she was discharged to the country for convalescent care. In four weeks the lumbar sinus had closed completely.

SUBPHRENIC BILIARY ABSCESS

While in the convalescent home she had three attacks of umbilical and right upper quadrant pain. She was readmitted June 2, 1933, for cholecystectomy. The operation was performed under avertin anaesthesia, supplemented by gas and oxygen. Through an oblique upper right rectus muscle-splitting incision, the peritoneal cavity was entered, the liver and gall-bladder were obscured by omental adhesions, upon separating these, the liver was found retracted well beneath the costal margin, its upper surface adherent to the diaphragm by fibrous adhesions. The gall-bladder itself was chronically inflamed and thickened, measuring about five inches in length with an average diameter of two inches. It was surrounded by the omentum and the fundus was adherent to the hepatic flexure, and the ampulla to the duodenum by dense adhesions. In the mid-portion of the gall-bladder was a broad band of fibrous adhesions, evidently the point of a previous perforation. The cyst duct was slightly dilated and opened at an oblique angle into the common duct. At the neck of the gall-bladder, a freely movable stone the size of an olive pit was found. The liver itself appeared normal. There were no stones in the common duct.

A typical retrograde cholecystectomy was performed and drainage instituted. The recovery was smooth and the patient was discharged on the fourteenth post-operative day.

The speaker remarked that cases of silent perforation of an inflamed gall-bladder into the subphrenic space are rare and but few have been reported. A careful history failed to elicit the presence of any acute abdominal symptoms although the patient had several episodes of typical gall-bladder colic. Even though there was over a gallon of bile in the right subphrenic space, there was no chest pain, dyspnoea, or cyanosis. Evidently the bile leaking from the perforated gall-bladder accumulated so slowly and so gradually that ample opportunity was afforded for readjustment of the respiratory organs. The single stone in the gall-bladder acted as a ball valve, first allowing the bile to escape through the perforation into the subphrenic space, and then finally slipping back into the cystic duct to obstruct the further flow of bile, thereby permitting the perforation of the gall-bladder to heal.

DR DEWITT STETTEN said that this presentation not only called attention to the rather rare silent perforation of the gall-bladder, but also illustrated a relatively unusual cause of subphrenic abscess. Perforation of the gall-bladder or suppurative cholecystitis is, at least in the experience of the speaker, very rarely followed by subphrenic abscess. He had found that, if there is a pocketing, it is usually subhepatic in character. The speaker had seen two cases of subphrenic abscess following gall-bladder disease. The first was an elderly man with an extensive subphrenic abscess, apparently originating from the gall-bladder region. It was drained in the usual manner but the suppuration extended into the right chest and the patient finally succumbed to the infection. As an autopsy was not obtained, the suspicion that this subphrenic abscess originated from the gall-bladder was never proven. In the second case the patient had a primary empyema of the gall-bladder and developed a typical subphrenic abscess, which was drained forty days after the primary operation, and was followed by prompt recovery.

ABDOMINO-PERINEAL RESECTION FOR TUBERCULOUS SIGMOID, RECTUM AND PERI-ANAL TISSUES

DR JOHN J. WESTERMANN presented a woman, aged forty-five, who was referred to him April 23, 1931. She had been operated upon for a con-

dition simulating hæmorrhoids in 1927. This had followed a period of poor health since the birth of her last child five years previously. Almost immediately following the hæmorrhoid operation, she noticed a severe excoriation about the anus and buttocks which gradually increased in area. There were also recurrent attacks of diarrhoea. There was a gradual loss in weight and onset of general weakness.

On her first admission to the hospital a biopsy was made from the skin of the buttocks, the anal tissue and sigmoid and rectal walls. The microscopical examination of these tissues was as follows: (1) Skin of the buttocks involved in an extensive chronic inflammation with a formation of many discreet tubercles. There were a few typical Langhan's giant cells and endothelial cells forming discreet tubercles. There was comparatively little necrosis. (2) Tissues from the hæmorrhoidal tabs and the rectal wall showed more tubercles typical of the disease. As a whole the lesions were characteristic of tuberculosis. Examination of the sigmoid showed the same lesions.

She remained at the hospital until May, 1931, and then was referred to her physician for local sun-lamp treatments and general hygienic care. She remained fairly well until July, 1932, at which time she began to lose weight rapidly (forty pounds in six months). The lesions about her anus and buttocks became markedly worse, there was complete loss of sphincteric control, continuous diarrhoea and vomiting. She was admitted to the hospital again February 9, 1933, at which time a high left-sided colostomy was done. Following this her diarrhoea ceased and she gradually began to improve, both in general health and in the local condition. She was discharged May 23, 1933, to St. Luke's convalescent home. She was returned from there September 8, this year having gained thirty pounds. She was in apparent good health. There was a marked improvement in the peri-anal lesions. September 14, an abdomino-perineal resection was performed, removing the sigmoid and rectum from the point of colostomy. This case was presented to the Society as one of interest in connection with Doctor Berry's paper, although she is still convalescent.

TUBERCULOSIS OF THE RECTUM

DR JOHN A. MCCREERY presented a man who was admitted to Bellevue Hospital December 25, 1919. His age at that time was forty-three. His chief complaint on admission was pain in the region of the rectum, increased on defecation. His past history was negative except for the loss of fifty pounds in weight in the previous eight months. Examination showed an ischiorectal abscess which at operation was found to involve both ischiorectal fossæ. Incisions were made on both sides and the wounds packed. He was discharged one week later to the out-patient department and readmitted February 16, 1920, because of persisting purulent discharge from both wounds. At operation at this time the fistulæ were laid open and partially excised. The wounds were packed with iodoform gauze. No communication with the rectum was found at this time. The patient was discharged one month later having gained twenty pounds but with sinuses still present extending about two inches into the ischiorectal fossæ. Examination of the tissue removed at operation showed the presence of tuberculosis.

The patient was treated in the out-patient department for six months. He was readmitted because of persisting discharge from sinuses on either side of the anus, and was operated on for the third time October 13, 1920. At this time a horseshoe fistula was found involving both ischiorectal fossæ, on the left side extending through the levator ani. The fistulæ communicated with each other behind the rectum, but no opening into the intestine was found, although the fibrous tissue which made up the outer wall of the

PERI-ANAL TUBERCULOSIS

fistula infiltrated the internal sphincter. There were many short lateral tracts extending from the main sinus.

After injection of the sinus with methylene blue a thorough dissection was made extending on the left side through the levator and removing completely all of the fibrous wall of the fistula in the ischio-rectal fossa. It was impossible to completely remove the scar tissue above the levator and the remaining portion of the tract was cauterized with carbolic acid. The wound was packed widely open with iodoform gauze. The operation took two hours and a quarter. The patient's condition at the end was satisfactory. During the following month the patient was dressed every three days under gas anaesthesia. It was found that the cavity closed steadily from above. At the end of six weeks there were two small sinuses extending up about two inches still communicating with each other behind the rectum. Eight weeks after operation it was found that the wound on the right side was entirely healed but on the left side there was a communication into the rectum at the mucocutaneous junction. This tract was excised in a fourth operation December 13th two months after the preceding procedure. It was then found that in addition to the superficial fistula there was a short tract leading upward beneath the mucous membrane.

He was discharged three months after his admission with the wound on the right side healed while on the left side there was a small superficial sinus. This was treated in the out-patient department and gradually closed healing four months after discharge from the hospital. He has been seen at intervals in the last twelve years.

His general condition has always been good and at no time either in the hospital or in follow-up has there been any evidence of pulmonary tuberculosis. He was now presented in connection with Doctor Berry's paper to emphasize the fact that cure in cases of this sort is possible with a radical operation and careful post-operative treatment.

PERI-ANAL TUBERCULOSIS

DR FRANK B. BERRY read a paper with the above title for which see p. 593.

DR HENRY W. CAVE said that Doctor Berry had clarified in the mind of many this whole subject of peri-anal tuberculosis. He had dispelled the myth that practically all cases of fistula in ano were tuberculous in origin. From the literature of others in recent years and from his own experience Doctor Cave has found that most cases of fistula in ano are due to pyogenic infection and that only from 5 per cent to 10 per cent are tuberculous. One often finds hæmorrhoids where there is a co-existing fistula. Neglected hæmorrhoids are a source of infected crypts and it is usually in an anal crypt that the internal opening of the fistulous tract is found. Doctor Berry admits that in active pulmonary tuberculosis probably 75 per cent or more are likewise tuberculous but that in the arrested cases only 15 per cent to 20 per cent are tuberculous. The increased incidence of peri-anal tuberculosis in sanatoria where tuberculous patients are hospitalized is striking. At the Roosevelt Hospital in a twenty-three and a half-year period from 1910 to the present time they have operated upon 1148 patients with peri-anal lesions exclusive of hæmorrhoids or new growths twelve of these were cases of proven tuberculosis, fistula in ano 550, ischio-rectal abscess 481, fissure in ano 106, ulcer of anus 11. They have not done guinea-pig tests.

nor isolated tubercle bacilli from the secretion of the lesion, diagnosis being made from the microscopical slides. There were seven other cases in the records diagnosed as peri-anal tuberculosis, but after the present pathologist went over them they were thrown out as inconclusive. Of these twelve cases two were suffering from active tuberculosis, six were in a quiescent stage and in four cases no mention was made of any tuberculous process co-existing in any other part of the body. Ten males, two females, ten were fistula in ano, one anal ulcer, and one anal ulceration associated with tuberculosis of the last two inches of the rectum and anal openings, that patient died seven days post-operative from peritonitis, resection of the rectum had been attempted. Doctor Cave said that he had used the reverse Trendelenburg or jack-knife position advocated by Doctor Buie as most convenient in operating upon the anus and rectum. Surgical excision is assuredly the method of cure and should be attempted on all these cases. Doctor Buie has a record of 72.5 per cent cures which is creditable. The secret of success in operations for fistula in ano depends upon two things: first, complete excision of the true internal opening of the tract, second, no matter how far the incision may run over the buttocks the tract should be left wide open and packed each day from the bottom up until the granulation tissue practically comes to the level of the surrounding skin. Medium-sized tape is pressed down with the finger or flat instrument into the tract. Usually in these cases Doctor Cave has used spinal anaesthesia or novocaine anaesthesia without any mishap. In regard to Doctor Berry's statement that the bowels were not allowed to move for five or seven days, Doctor Cave had abandoned that practice as obsolete and advises the instillation of oil the afternoon of the operation and an oil enema the following morning. Hot fomentations over the anal opening and frequent oil enemas are most comforting. It is a pity that more care is not taken in these cases of peri-anal tuberculosis who are generally left to the house surgeon at the end of the schedule and without proper guidance and supervision of an attending surgeon.

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LIGATION OF THE GREAT VESSELS OF THE NECK*

BY GEORGE M. DORRANCE, M.D. †

OF PHILADELPHIA, PA.

THE latter years of the eighteenth century and the beginning years of the nineteenth witnessed the first ligations of the carotid arteries of the neck. It is for approximately 150 years, therefore, that these ligations have been practiced.

Probably every surgeon who practiced in the nineteenth century, and almost certainly every living surgeon today has performed or has had personal contact with the surgery of these vessels. In spite of such widespread knowledge and tremendous total experience, the question of whether to ligate the common carotid or internal carotid primarily when a choice is presented remains a source of controversy whenever mentioned. Such controversy has its origin, of course, in the cerebral complications which so frequently follow the obliteration of either one of the main vessels.

At the moment of ligation or immediately thereafter, the patient may experience a sense of fainting combined with nausea and vomiting, cold sweat, ringing in the ears, and darkening of the fields of vision. These symptoms may be of a few seconds' duration only, or may be associated with homolateral headache, aphasia, partial or complete contralateral hemiplegia with anæsthesia and paræsthesia, and persist for days or weeks. The majority of these symptoms have a tendency toward improvement and usually completely disappear after a longer or shorter period of time. Too numerous are the patients, however, who develop permanent hemiplegia, with or without aphasia, blindness and mental deterioration. Too frequent also are the cases where the above symptoms precede by a few minutes only a deepening and slowing of respiration, generalized convulsions and death. If none of these signs or symptoms complicates the operation itself, the surgeon must still face an uncertain period of from several days to a week or ten days during which the signs of severe cerebral disturbance may suddenly occur, with hemiplegia or with death closing the scene.

Five theories are championed in interpretation of these cerebral disturbances.

First, anæmia due to failure of collateral circulation chiefly because of anomalies of the circle of Willis. Second, thrombosis and embolism. Third,

* 1933 Annual oration read before The Philadelphia Academy of Surgery.

† The author wishes to acknowledge the assistance of Dr. Paul Loundsleger in the preparation of the statistical matter contained in this paper.

ischæmia—vasoconstriction due to sympathetic irritation Fourth, circulatory stasis Fifth, intracerebral hæmorrhage

I have added a sixth thought, "cerebral injury independent of ligation," because it must be recognized, as Ramsay Hunt³² reminds us, that "not all cerebral complications can be attributed to the ligation itself inasmuch as sepsis, meningitis, *etc*, must be considered" Cerebral injury may, and often does, complicate the head injury or intracranial lesion which dictated the occlusion of the carotid vessel

The fifth theory may also be admitted without discussion Herman Pearse⁵⁶ suggests "might not these cerebral symptoms be due to increased arterial pressure inasmuch as they come on suddenly after ligation and are most apt to occur in a subject past middle life whose cerebral vessels are subject to rupture? It is significant that aneurisms and hemiplegia are manifestations of the same vascular disease" The occasional cerebral complication may be due to vascular rupture

Under the first theory, the term "brain anæmia" conveys the idea that the total amount of blood supplied to the brain in a given unit of time has been reduced to a point where nutritional want or death of the cerebral tissue occurs Insufficiency of the collateral circulation, chiefly because of anomalies in the circle of Willis, is generally held responsible for this diminished volume flow

The thrombosis and embolism theories would explain that cerebral complications result when a preformed thrombus, or a clot which is the result of operative manipulation, is loosened and swept into the cerebral vessels Complications occurring after an interval of days are supposed to result from thrombosis arising at the point of ligation and advancing by progressive coagulation into the intracranial channels LeFort⁴¹ believes all the late effects to be due to thrombosis from the site of ligation, advancing, in the case of common carotid ligations, to the bifurcation of the common carotid, where the recurrent flow from the external carotid may sweep away an embolus

Under the concept of sympathetic irritation, there is visualized a homolateral ischæmia of the brain, as the result of tonic vasomotor spasm of the cerebral vessels, induced by irritation of the sympathetic nerve filaments in the neck In the words of Weiting,⁷⁰ "a spastic contraction of the arteries at the base of the brain impedes for a time the formation of collateral circulation"

The least discussed theory explains cerebral symptoms on the basis of a circulatory stasis The exact mechanism by which stagnation is produced is not uniformly described Friedlander²⁴ maintains that with one channel of blood supply cut off, there occurs an imbalance of the hydrodynamic equilibrium of the circle of Willis, with consequent poor penetration of blood into the peripheral vasculature

Depending upon which theory appears most reasonable to him, the individual surgeon will use procedures which seem, in the light of that theory, most likely to avoid these cerebral complications

LIGATION GREAT VESSELS OF NECK

PROCEDURES ON CAROTID ARTERY

- (1) Preliminary compression of the common carotid over the tubercle of the sixth cervical vertebra
- (2) Preliminary narrowing of arterial lumen by metal bands
- (3) Gradual throttling of lumen by clamps³⁴ or fascia bands³⁷
- (4) Simultaneous ligation of internal jugular vein
- (5) Preliminary clamping for several hours of vessel to be ligated
- (6) Ligation of internal carotid
- (7) Ligation of common carotid
- (8) Ligation of common carotid with simultaneous ligation of external carotid
- (9) Ligation of common carotid with subsequent ligation of a varying number of the branches of the external carotid
- (10) Ligation of common carotid with subsequent ligation of the internal carotid

Differences of opinion are understandable for many aspects of the problem remain in the realm of speculation. It has not been found feasible to observe the human brain under experimental conditions and the results of experiments upon animals are not always strictly applicable to man. The findings at autopsy furthermore, are confusing. The post-mortem findings consist of anæmic infarcts but anæmic infarcts are difficult to produce experimentally and pathologists disagree as to the mechanism of their production.

Another confusing factor is presented in the question of thrombosis and embolism. Only a few of the many variables which seem to be involved in the formation of thromboses are susceptible of estimation for clinical use.

Many observations, however, and many enlightening contributions have been made in vascular surgery, physiology, pathology, ophthalmology, and neurology which may be adduced to this particular problem. Demonstrations and conclusions to the study of problems in these other fields, when applied here, make it appear possible to formulate a rational program of procedure.

Anatomy and Physiology—Inasmuch as the most common explanation of cerebral sequelæ predicates an anæmia of the brain in the sense of a reduced volume flow of blood, it is appropriate at the outset to review the anatomy of the vessels and to refresh our memories with regard to the channels of collateral circulation. Unlike the extremities, and most organs of the body which depend for their nutrition upon one main artery, the brain is abundantly supplied by four great vessels—each originating in the high-pressure areas of the aortic arch or the subclavian vessels. No part of the body seems so efficiently protected against failure of blood supply as the brain.

Each internal carotid equals the basilar in diameter and it would be more correct probably to say that the brain is supplied by only three main vessels. On the basis of such calculation, the obliteration of one internal carotid should reduce the volume flow to the brain by one-third. The exact amount of reduction in any given patient would be difficult to estimate, as compensatory dilata-

tion of the collateral channels is very prompt. The relatively greater volumes, however, carried by the carotids should be borne in mind when and if anyone contemplates such an undertaking as bilateral ligation of the common or internal carotid. In spite of the few successful bilateral ligations on record, it is not a rational procedure. The reduction by two-thirds of the volume flow to the brain is too great to be successfully restored by the otherwise generous collateral provisions with which the brain is supplied. Those few patients who have survived bilateral ligation have almost invariably shown mental deterioration. The importance of the opposite carotid, moreover, should not be lost sight of in unilateral ligations. Homans³¹ and Guinard²⁶ sounded this warning after each, having ligated a common carotid, autopsied their patients and found only weakly developed and poorly functioning vessels opposite the ones they ligated.

After ligation of the common carotid artery, the circulation to the brain is carried through (1) the opposite internal carotid, (2) the circle of Willis, (3) the angular with the ophthalmic, (4) the internal carotid on the side ligated by means of the reversed currents down the external carotid and past the bifurcation. This reversal results from the following anastomoses: (a) the inferior with the superior thyroid, (b) the deep cervical branch of the costocervical trunk with the descending branches of the occipital, (c) the superior thyroid, lingual, facial, occipital, and temporal, with the corresponding arteries of the opposite side.

Ample evidence is afforded in individual case reports that these named vessels dilate rapidly and carry vigorous circulation around a ligature upon the common carotid.

In addition to these larger well-known channels, there are numerous other anastomoses between smaller vessels of the two sides. Thus, Elschni¹⁷ showed that when in the cadaver the ophthalmic artery was divided from the internal carotid, the latter tied and a liquid, under the low pressure of 60 mm of water, was injected into the external carotid or internal maxillary of the same side, such liquid could be seen to flow from the cut end of the ophthalmic in a relatively short time, and that finally both orbits and both sides of the face were filled with the injection fluid. He concluded that "the ocular blood supply must be in part derived from the external carotid, the branches of which communicate freely on both sides." Dawbarn¹² remarks that "it is known to everyone that there are thousands—myriads—of nameless little vessels interlocking at the median line by which the freest anastomoses are quickly restored. Even after bilateral ligation of the external carotids, the resulting anæmia is of short duration only," and "after complete excision of the superficial carotids on both sides with each of the eight branches on both sides separately controlled, there remained twenty-nine distinct routes by which blood could still enter the area from outside systems."

The retrograde flow from the anastomoses of the external carotid down the external, past the bifurcation, and into the internal has been recognized

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by at least twenty authors whose writings have been brought to our attention. The following men speak of it as an accepted fact: Baroni,⁴ Caudry,⁸ Fisher,²⁰ Freeman,²² Guinard,²⁶ Katz,³⁵ Keegan,³⁶ Kolodny,³⁸ Kriampf,³⁹ LeFort,⁴¹ Lenormant,⁴³ Le Fournestieaux,⁴² Matas,⁵⁰ Perthes,⁵⁷ Ransohoff,⁵⁹ Romanis and Mitchner,⁶⁰ Stiellin and von Meyerberg,⁶³ Trotter,⁶⁶ Whale,⁷¹ and Weeks and Gilson.⁶⁹



PLATE A

In attacking an arteriovenous fistula of the left internal carotid-jugular tract at the bifurcation, Matas⁵⁰ placed an aluminum band on the common carotid and another on the internal jugular vein just above the clavicle. Re-opening the wound some time later, he found the fistula still active and fed by an arterial current coming down the external carotid and into the internal and through the fistula into the jugular. Placing clamps upon the internal and external carotids and upon the internal jugular above the fistula, he performed an endo-aneurismorrhaphy, removed the clamps, and found the circulation down the external and into the internal soon reestablished.

Lenoirmant¹³ comments upon an operation in which he assisted Petit-Dutailis to resect an aneurism of the bifurcation with an immediate end-to-end anastomosis of the stump of the external carotid with that of the internal carotid. He remarks that in the course of the operation the clamp slipped of the internal carotid and he was surprised to see practically no bleeding, indicating a very small pressure down the internal carotid. After reunion of the two vessels, good pulsations were immediately established in both vessels. There were no cerebral complications and about one year later he still found good pulsation in both vessels. My own experience I have recounted

before¹⁶. Reopening the neck three weeks after ligating the common carotid, I found the internal and external pulsating above my ligature. By clamping as indicated (Plate B) and using various combinations of the clamps in the positions indicated, I demonstrated that the blood was flowing under good pressure down the external and up the internal. I have verified this phenomenon in about a half-dozen ligations since I first observed it three years ago. As a result, I have arrived at the following rough estimations:

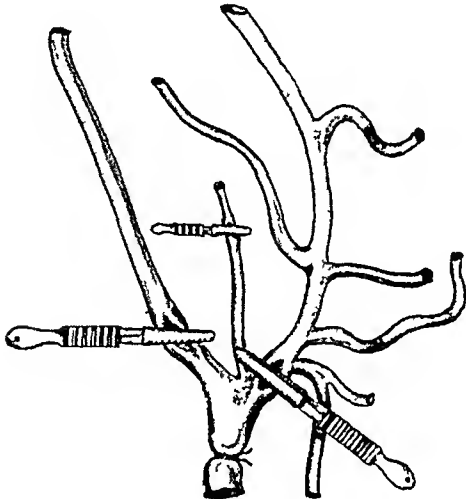


PLATE B

Ligation of the common carotid reduces the blood flow in the internal carotid by about 50 per cent. Almost half of the recurrent flow from the external carotid comes through the superior thyroid. With confirmatory observations by other men, I believe that this retrograde current through the external carotid is a normal phenomenon after ligation of the common carotid, and that it may be looked upon as a very important channel of collateral circulation to the brain when the common carotid is ligated.

Inadequacy of the collateral circulation through the circle of Willis is commonly held responsible when cerebral symptoms follow internal or common carotid obliteration. This impression has been made, most likely, by isolated reports of autopsies in which deficiencies in the circle have been found. In 1889, S. Weir Mitchell¹⁴ called attention to sixteen anomalies in the posterior communicating arteries, in nine of which these vessels were absent or impervious. In 1905, DeVries¹⁵ noted forty-five of the same vessel, in seven of which both arteries were absent. The difficulty with these reports is that they give no estimation of how many times these anomalies occur in consecutive autopsies,—that is, whether we should expect to find sixteen, or forty-five, anomalies in each 500, or in every 5,000 persons.

In Fawcett's and Blackford's studies¹⁸ of 700 consecutive autopsies and in Windle's⁷² of 200, we may be able to obtain fairly reliable averages

LIGATION GREAT VESSELS OF NECK

	COMPLETE AND SYMMETRICAL			
	Fawcett and Blackford		Windle	
	510	72 8%	103	51 5%
Complete but asymmetrical				
Left posterior communicating larger than right (Plate C, Fig 1)	64		15	
Right posterior communicating larger than (Plate C, Fig 2)	87		28	
Left posterior cerebral from internal carotid (Plate C, Fig 3)	4		9	
Right posterior cerebral from internal carotid (Plate C, Fig 4)	6		11	
Interior communicating shaped	2		—	
Total	—	163 23 3%	Total —	63 31 5%

INCOMPLETE

Left posterior communicating absent (Plate C, Fig 6)	10		13	
Right posterior communicating absent (Plate C, Fig 7)	13		9	
Both posterior communicating absent (Plate C, Fig 8)	3		3	
Anterior communicating absent (Plate C, Fig 9)	1		9	
Total	—	27 3 8%	—	34 17 %

Analyzing the incomplete items, Fawcett and Blackford¹⁸ remark that "one posterior communicating vessel is sufficient to maintain the circle" Windle⁷² notes that in every case in which he found one or both posterior communicating vessels absent, there were communicating vessels present between the basilar and internal carotids (Plate C, Fig 10) In other words, in twenty-five of the thirty-four specimens, in which he noted anomalies, there was no actual deficiency Furthermore, in seven of the nine absences of the anterior communicating vessels, the absences were due to fusion of the anterior cerebrals (Plate C, Fig 9), where a communicating vessel would be superfluous In the remaining two, there was absence of the anterior cerebrals on one side (Plate C, Fig 11), and the cases were insane subjects This leaves one missing anterior communicating vessel in 900 fully developed brains Busse⁷ examined 400 brains for the anterior communicating artery only He found none absent, and in 227 of these 400, the anterior vessel was multiple We may assume, therefore, that absence of the anterior communicating artery is

an extremely rare happening—only one being absent in 1,300 brains which were examined

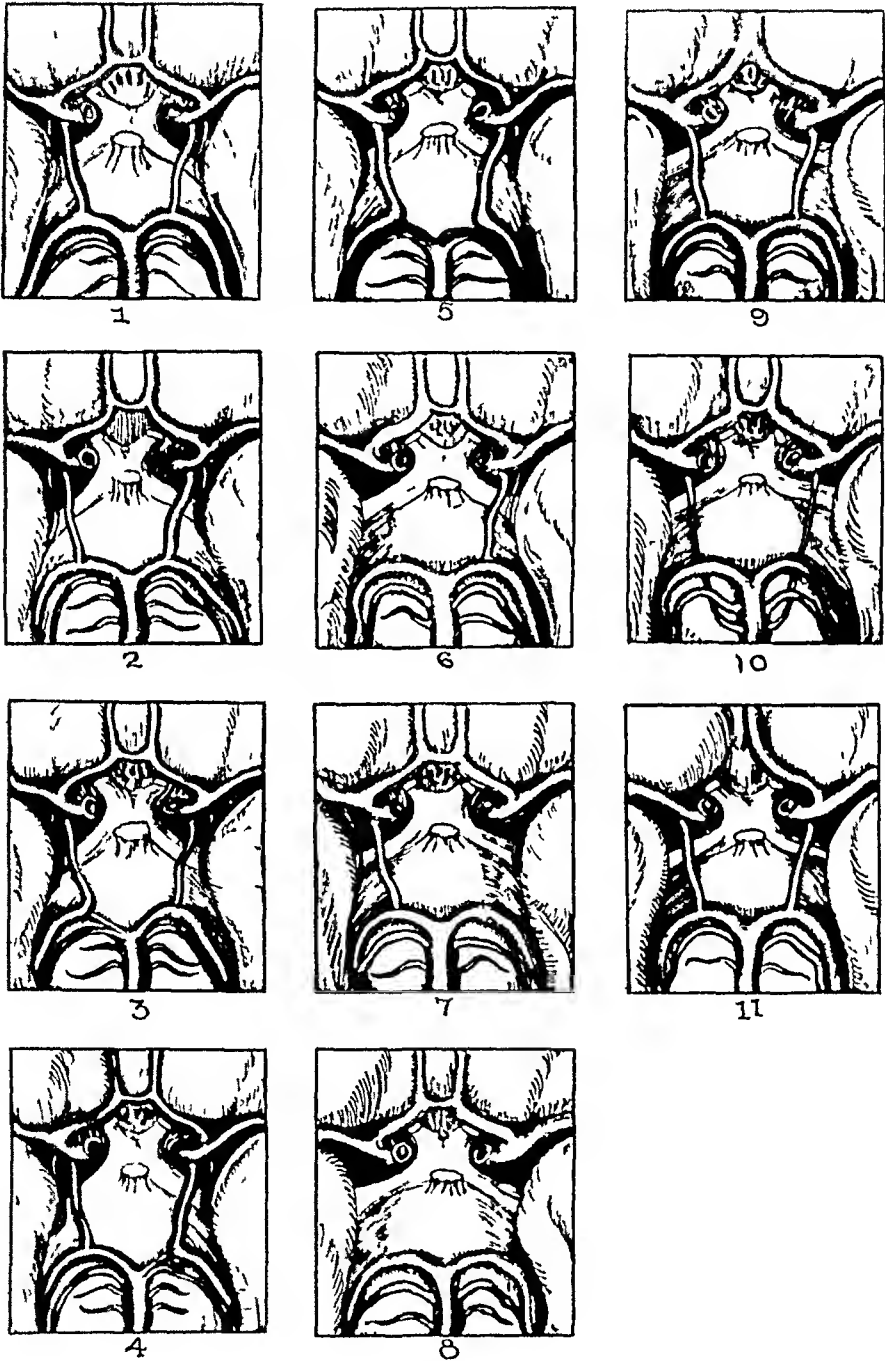


PLATE C

In the posterior half of the circle, frequent mention is made of the absence of one or both posterior communicating vessels, but Windle notes that in every case the absence of these vessels was compensated for by other vessels con-

necting the two halves of the circle. Therefore, while anomalies occur, they do not occur so commonly as symptoms following ligations. When anomalies of the circle of Willis are encountered, the question may be asked—do they adversely affect the blood supply to the brain? D. J. McCarthy and M. K. Meyers,⁵¹ Pfeiffer,⁵⁸ Friedemann,²³ and others^{13 75 31} do not believe so. McCarthy and Meyers state, "It has been shown experimentally that constant pressures are maintained in the vessels of the circle of Willis when the blood supply of one of its branches, or its supply artery, is cut off," and that "irregularity in the size of the individual vessels of the circle of Willis would not, in all probability, have any disturbing influence either as to structure or function." Le Fournienstieux believes such anomalies to be of little importance as "considerable variation is compatible with functional efficiency." Zimmermann⁷⁴ comments upon the number of autopsies in which no anomaly of the circle of Willis was noted. Homans was unable to find in the literature any death following a carotid ligation in which an anomaly of the circle was demonstrable. Friedemann and Elkeles performed the interesting experiments on dogs of perfusing dye materials through each of the four nutrient vessels of the brain while the other three vessels were ligated. In every instance, they found all parts of the brain uniformly stained. Such experiments on the dog may be said not to hold true in the human brain, but the recent monumental work of Pfeiffer⁵⁸ on the anastomoses of the cerebral blood-vessels would incline one to believe it. Pfeiffer demonstrates, macroscopically and microscopically, a regulating mechanism within the brain of an extremely complicated but purposeful architecture. In this regulatory mechanism he demonstrates vessels which he terms "throttles" for lowering pressures and "injector vessels" for speeding up the circulation, by means of direct connections between the basal vessels and capillary beds. For equalizing pressures between two or more remotely situated capillary beds, there are vessels of greater calibre than capillaries, and these connecting vessels possess the ability to reverse currents. Reversible currents are common, as are also anastomoses, in all parts of the brain, between arteries, and between arteries and veins. Consequently, it is believed that all blood which reaches the basal arteries is distributed equally and under constant pressure to all parts of the brain. A reduction in total volume reaching the basal vessels would, in the same way, affect evenly every area of the brain.

With a normal carotid vessel on the opposite side of the neck, with the knowledge that anomalies of the circle of Willis are rarely of sufficient importance to impair its functional integrity, with recognition of the many collateral avenues through which blood may reach the brain when one carotid is obliterated, it is difficult to ascribe all of the many reported complications to an anæmia of the brain.

We would not have you think we deny the possibility of any reduction in volume flow to the brain. Quantitative reductions do occur. It is for this reason that we advise primary ligation of the common carotid with subsequent ligation of branches of the external instead of primary ligation of the internal

carotid We do deny, however, the theory that reductions are of such magnitude as to account for all of the many accidents reported

Thrombosis and Embolism—Turning to the question of thrombosis and embolism, it will be necessary to summarize Discussion in detail of the many concepts relative to these phenomena would lead us too far afield In such a summary, we find universal agreement with the statement of Ludwig Aschoff² that “thrombosis is the function of a number of variables” In other words—it has no single cause

The variables listed by Aschoff consist of slowing of the blood-current, changes in the vessel wall, changes in the blood plasma, and changes in the blood elements

Variables in the Production of Thrombosis—First, slowing of the blood flow, second, changes in the vessel wall, third, changes in blood plasma decrease in coagulation time, increase in decomposition products, increase in protein substance, increase in blood CO₂, increase in blood calcium, increase in fibrinogen-globulins, fourth, changes in blood elements decrease in sedimentation time, increase in leucocyte count, increase in platelet count

Undoubtedly many of these factors influence thrombosis, as they have been observed clinically associated with thrombosis Several facts in connection with these observations, however, must be noted In the first place, it is agreed that not all of these factors are operative in each and every case of thrombosis Secondly it is agreed that no one of these factors is in itself sufficient to produce thrombosis

The experiments of Baumgarten,⁵ in which he found blood in the doubly ligated segment of an artery, remaining fluid over a period of days, have been amply confirmed by Malyschew,⁴⁷ Delrez,¹⁴ McLean,⁵² and Armentrout¹ We must accept as true the conclusion that slowing and stagnation alone do not produce thrombosis In 1915, McLean,⁵² in a large series of animals, discovered that repeated crushing of vessel walls resulted in a thickening of the vessel wall only, the intima remaining smooth and glistening with no suggestion of thrombosis In 1929, Miller and Rogers⁵³ had a similar experience, and definitely showed that an uncomplicated injury to a vessel wall does not cause thrombosis It is common knowledge, moreover, that all of the changes in the blood plasma, and in the blood elements, noted in cases of thrombosis and embolism, are also observed in various states of health and disease where no thrombosis occurs It is not a correct conclusion to assume that the blood changes observed associated with thrombosis are alone responsible for that thrombosis

Of the three primary factors, slowing of the blood-stream, changes in the blood wall, and changes in the blood itself, it appears that at least two must operate simultaneously

Distillation of the enormous number of experiments, clinical studies, and the conclusions therefrom, would seem to present us with one basic fact That one fact is that changes of a marked character in the blood itself are essential to the production of thrombosis In addition, at least one other

factor, either of stasis, or of vascular wall damage, is essential, but the rôle of either consists in acting as a precipitating or localizing agent. Miller and Rogers made the interesting discovery from a study of all cases of thrombosis and embolism occurring in the Massachusetts General Hospital between the years of 1900 and 1927, that the site of operation, the extent of operative trauma, and wound infection did not appear to be of major importance, inasmuch as the primary thrombus was usually found in the femoral or iliac veins, regardless of the site of operation. The decrease in the rate of circulation was designated as the most important single factor, and was thought to be due to the long recumbent position in bed, plus the depression of the circulation produced by anæsthesia and operative procedures. Miller and Rogers admit, however, that other factors were present. These other factors consisted of changes in the blood predisposing to thrombosis, and a localizing factor in the veins indicated. In purely medical cases, thrombosis and embolism are most frequently encountered in states of marked debility, such as those of advanced cancer, acute infections, and advanced cardiovascular disease. Here many and severe changes in the blood are easily demonstrable. The precipitating causes are slowing of the blood current secondary to cardiac decompensation, and localized vascular disease. In the field of traumatic surgery, the factor of local infection plays a more important rôle, but it should be noted that, even in such cases, thrombosis occurs only when the local reaction is sufficient to produce blood changes, and the local slowing of the blood-stream and the local damage to the vascular walls are sufficient to precipitate the reaction of thrombosis.

An important observation in regard to wound infections in the vicinity of arteries is that infections do not seem to produce thrombosis except where the infectious agent is able to penetrate the vessel wall and act directly upon the slowed or stagnated blood-stream. It is for this reason that, in the presence of wound infection, the occurrence of a secondary hæmorrhage through sloughing of ligatures, or by erosion of the vessel wall, is a more frequent complication than thrombosis. When, however, there be devitalization of the vessel wall with subsequent necrosis of that wall and the products of that necrosis act directly upon a stagnated column of blood within that vessel, coagulation thrombosis almost invariably occurs. The media of arteries is rich in thromboplastic substances, and necrosis of a vessel may be an aseptic process, and still produce coagulation thrombosis. In the small amount of blood stagnated in the vicinity of a ligature, if any of the vessel wall be compressed sufficiently to produce necrosis, the concentration of thromboplastic substances released into that small amount of stagnated blood may produce coagulation. Torracco⁶⁴ demonstrated this fact in 1929 when, in spite of rigid asepsis, he found thrombi constantly present when he used coarse or redoubled ligatures. This finding of Torracco was confirmed by Barcaroli³ in 1931 and both confirm the earlier demonstrations of Marchand,⁴⁹ and Travers⁶⁵. For the same reason, the presence of foreign bodies, in contact with the vessel ligatured, was found to be important in the determination of thrombosis. A

higher incidence of thrombosis is noted also when clamping of an artery preceded its ligation

Knowledge of these facts explains the difficulty with which thrombosis is produced in the experimental animal. Healthy vigorous animals are used, rigid asepsis is preserved, the animals are restricted in their activity for the duration of the operation only, and the presence or absence of thrombosis depends upon the amount of vessel wall devitalized.

It is evident, therefore, that with reasonable asepsis, there is no more reason to anticipate local thrombosis, after ligation of the carotid vessels, than after ligation of a vessel in any other part of the body. As a matter of fact, no more do occur, and thrombosis of a cerebral vessel as a result of a thrombosis arising from the point of ligation of a carotid vessel, or cerebral embolism by fragmentation of a local clot, does not account for the high incidence of cerebral symptoms following such ligatures.

Sympathetic Stimulation—In order to arrive at logical conclusions with regard to the rôle of sympathetic irritation in the production of the sequelæ of carotid ligations, it is necessary to return to our anatomy.

Lying on the prevertebral fascia, posteriorly and internal to the carotid sheath, the trunk of the sympathetic communicates with practically every nerve structure in the neck. It supplies vasomotor branches to the walls of the common, internal, and external carotid vessels, and their respective branches. It supplies motor fibres to the involuntary muscles of the orbit and eyelids, dilator fibres to the pupils, accelerator fibres to the heart, and secretory fibres to the salivatory glands. The superficial cervical ganglion lies opposite to the transverse processes of the second and third cervical vertebrae. The internal division of the ascending branch of this ganglion is known as the carotid nerve. It forms an arborization over this vessel and constitutes the nerve supply to the branches of the internal carotid. Stimulation of the sympathetic cord in the neck produces dilation of the pupils, protrusion of the eyes, paleness and coldness of the skin of the face and neck, dryness of the mouth and acceleration of the heart. Stimulation of the superior ganglion, or carotid nerve, produces constriction of the cerebral branches of the internal carotid on the same side of the head.

In the vessels of the extremities, Leriche⁴⁴ has attempted to demonstrate the important rôle played by the sympathetic nerves of arterial walls in the causation of the sequelæ of the ligations of these vessels. Sequelæ such as cyanosis, coldness, paralysis, and ulceration he believes to be due to vasoconstricting reflexes excited by the irritation of the sympathetic fibres in the vessel wall, when that wall is compressed by a ligature. He believes that the vasoconstricting impulses are more important than ischæmia in the production of these sequelæ. According to this conception of Leriche,⁴⁴ a ligated vessel, while no longer a channel for blood, continues to convey a group of sympathetic nerves in a state of chronic irritation. From his personal success in avoiding these sequelæ, by resection of a portion of a vessel, instead of simple ligation, he believes he cuts the channels through which these vasoconstricting impulses flow, and thereby produces peripheral dilatation.

Several objections militate against the strict application of this theory in ligations of the carotid vessels. The first objection is that, in the experimental animal stimulation and resection of the cerebral sympathetic is performed upon the superior ganglion or upon the carotid nerve, and not by manipulations of the carotid vessels. A second objection is that, should ischæmia, due to vascular constriction, constitute the mechanism of production of the symptoms often noted after the occlusion of one carotid vessel, the entire area of the brain supplied by that carotid should present more uniform softening in those cases which come to autopsy. Anatomically, the foci of the so-called white softening are limited as a rule to small areas and have no uniform distribution. Although frequently located in the regions of the basal ganglia, they may be as far removed as the occipital lobes. In the third place, from a clinical viewpoint, it should be noted that were conditions exactly analogous in the neck and in the extremities, we should expect sequelæ to follow obliteration of the carotid vessels as frequently as coldness and cyanosis follow obliteration of the main vessel of an extremity. Furthermore, we should expect these sequelæ to occur in young subjects almost as frequently as in those of more advanced years. The fourth and most important objection is that stimulation of the sympathetic does not produce the symptoms which are observed after ligation of the common or internal carotid. Stimulation of the cervical sympathetic produces coldness and paleness of the skin of the face and neck, dryness of the mouth, acceleration of the heart, and an increase in blood-pressure. This is the picture of sympathetic overactivity. The symptoms which occur after ligation of the common or internal carotid are those of shock, faintness, low blood-pressure, slowing of pulse, and cold sweat. This is the picture of vagus overactivity, and from an anatomical and operative view it would seem more likely that the vagus nerve might be irritated, in operating upon the carotid vessels, than that the sympathetic would be irritated.

In man, our sole opportunity to observe the reactions of a branch of the internal carotid under experimental conditions lies in the retinal vessels of the eye. Anatomically and from a developmental viewpoint, the ophthalmic artery is a part of the cerebral system of arteries and we may safely assume that the reactions of the ophthalmic artery are identical with those of the anterior and middle cerebrals. Recently, Gollwitzer and Schulte²⁵ made a study of the changes the retinal vessels undergo under conditions corresponding to ligation of the internal carotid artery. Simultaneous tracings record the systemic blood-pressures and the intravascular pressure below a clamp on the internal carotid. Arrows in the blood-pressure curve mark the moments at which calibre alterations in the retinal vessels were noted and photographed (Plate D). As the systemic blood-pressure begins to fall there occurs a constriction of the retinal vessels (Plate D, Fig. b), but when the blood-pressure continues to fall rapidly, and to a point far below its accustomed level, the constriction of the retinal vessel relaxes, the vessel walls pass into a state

of dilatation (Plate D, Fig c) and finally in a condition which might be termed flaccid paralysis (Plate D, Fig d) with almost complete arrest of the blood-stream filling them. In the youthful individual, the recovery from this abrupt extreme fall of blood-pressure is fairly prompt. In those of advanced years, however, whose blood-vessels have lost the resiliency of youth and

whose cardiac musculature moreover may no longer be capable of efficient response to unusual demands, the state of extreme depression may be prolonged.

Inman,³³ in 1920, and again last year directed our attention to the fall of blood-pressure and slowing of the pulse which accompanies the attacks of vertigo, paræsthesia, and transient hemiplegia, which are common episodes in the lives of hypertensive and arteriosclerotic patients. These symptoms have been ascribed to cerebral arterial spasms.⁴⁰ From the work of Inman they would be accounted for more properly by an acute passive congestion of the cerebral tissues. The cerebral complications of carotid ligations would not, therefore, seem to be satisfactorily explained on the basis of sympathetic stimulation. Vagus irritation would more adequately explain these complications and it is likely that a certain amount of vagus stimula-

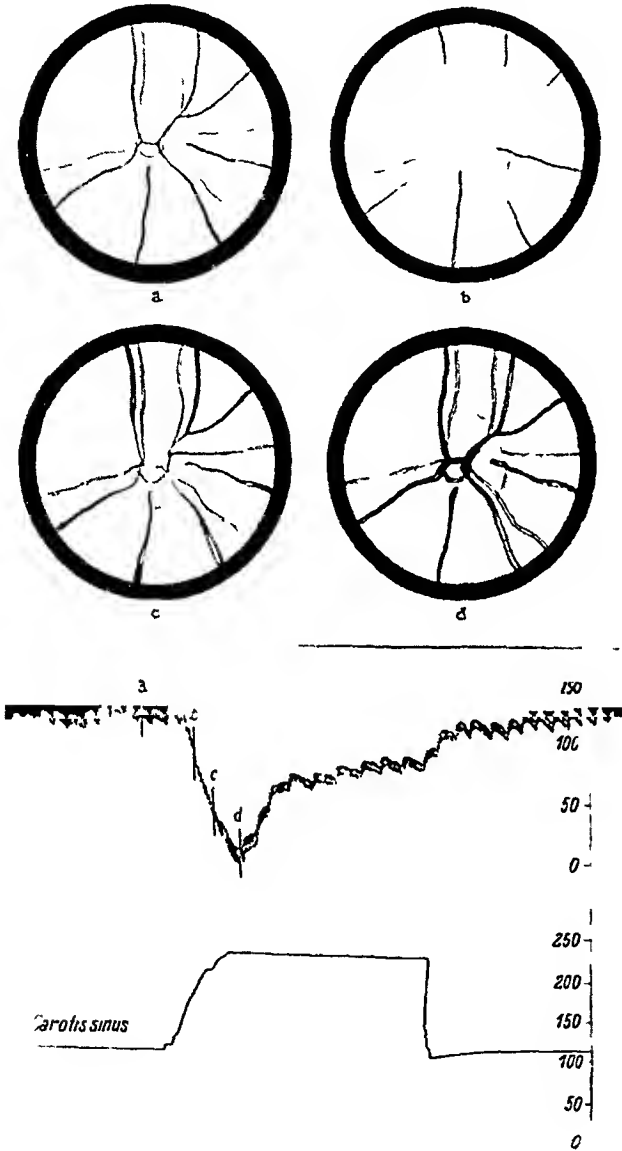


PLATE D (From Gollwitzer and Schulte)

tion occurs in every operation upon the neck.

Carotid Sinus—It would appear, from recent researches, that on the carotid vessels we have to deal with a mechanism which has received little or no publicity in America. I refer to the web of nerve filaments in the walls of the carotid bifurcation which has received the name of carotid sinus. Here the vessel wall is somewhat thinner than that of adjacent parts of the artery.

and contains in the deeper part of its adventitia a rich network of nerve filaments. This network is confined strictly to the limits of the sinus and forms the sinus nerve which joins the glossopharyngeal. Connections have been thought also to be made with neighboring structures such as the vagus, the superior cervical ganglion, and the hypoglossal. The mechanism thus constituted has been found to form the physiological component of the aortic nerves and, with the aortic nerves, exerts a powerful influence upon the heart rate, the blood-pressure and respiration. Because of their stabilizing influence upon the circulation, these nerves, the aortic and the sinus, have been termed by Wright⁷³ the "buffer nerves of the circulation." Their natural functions are depressive and their rôle in the physiological economy consists in acting as governors or counter-balances to the sympathetics. The carotid sinus part of the combination seems to be concerned particularly with regulating the circulation to the brain. The nerve terminals in the walls of the carotid sinus function as pressure receptors and as such are very sensitive to change in intravascular pressures within the carotid and also to extravascular pressures. Compression of the sinus or a rise of pressure within the carotid sinus produces a slowing of the heart rate and a reduction of blood-pressure, Thomas Lewis,⁴⁶ two years ago, showed that it is the stimulation of this carotid sinus mechanism which produces the syndrome previously described by him as "vasovagal syncope."

Slowing of the heart rate evidently takes place through the vagus, as, after paralysis of the vagus terminals by atropine, no slowing of the heart occurs. Electrocardiographical studies reveal that in the heart itself the effect consists of reduction in the conductivity of the bundle of His. In the presence of a damaged myocardium, a complete cardiac arrest has been known to occur. Lowering of the blood-pressure is accomplished by active vasomotor dilatation involving chiefly the splanchnic and cerebral areas. The vasodilatation is associated with an inhibition of adrenalin secretion. Further effects of stimulation of the sinus are seen in a decrease in rate and depth of respiration which may be so marked as to end in apnoea. Removal of all stimulation to the sinus, by reduction of pressure in the carotid, suppresses the activity of the sinus mechanism and results in the reverse of these phenomena. We see, therefore, an increase in heart rate and depth of respiration, accompanied by an increase in the secretion of adrenalin.

Details of the work which has produced this new knowledge is rapidly forming a large volume. Suffice to say that the work of Lewis,⁴⁶ Wright and Kremer,⁷⁴ Danielopolu,¹¹ Hering,²⁹ Gollwitzer and Schulte,²⁵ Mandelstamm and Lifshitz,⁴⁸ leave no room for doubt that we have here a perfectly normal structure whose activity is so far-reaching that it cannot be ignored in any operation upon the neck, and especially in any procedures upon the carotid vessels.

In the clinical use of this knowledge, some details should be noted. Mandelstamm and Lifshitz reported to the 1931 Congress of Internal Medi-

cine in Moscow their observations of this mechanism on 330 patients. They reported the following conclusions:

First, mechanical irritation of the carotid sinus in man released a strong depressor reflex upon the heart and circulation.

Second, control pressure over other vascular areas did not produce this reflex.

Third, there was no difference between the right- and left-sided reflexes, nor any difference between sexes.

Fourth, the frequency and intensity of reflexes showed marked difference at different ages.

In younger patients, it was possible to elicit the reflex in only 25 per cent of the subjects and in this 25 per cent the reflex consisted of a trifling reduction of blood-pressure for an average of 5 mm of mercury. In older patients, the reflex was elicited in 96 per cent of the patients and in these the fall of the blood-pressure averaged 37 mm of mercury. In patients presenting arteriosclerosis and hypertension, the depression bore an inverse ratio to the height of the original blood-pressure. In this group depressions were noted to the extent of 100 to 110 mm of mercury.

Other observers have recorded that the reflex is exaggerated by chloroform anæsthesia, by morphine, and by digitalis, that it does not seem to be affected by ether, and that its action is suppressed by local infiltrations of cocaine. The reaction furthermore shows no tendency towards fatigue. It is persistent so long as intravascular pressures remain constant. The reflexes reported have been produced by compression of the carotid vessels over the site of the sinus, or by increasing the intravascular tension.

It is obvious, therefore, that ligation of the internal carotid, with a building up of pressure back of the ligature, would tend to stimulate the sinus. Many of the symptoms noted after such a ligation could well be due to this mechanism. On the other hand, ligation of the common carotid reduces pressure within the sinus and thereby reduces its inhibitory effect. A complete release of inhibition over the cardiac accelerators may occasionally produce extra systoles and fibrillation. Demonstrations of such effects produced through the channels of the carotid sinus would nominate this sinus as of major importance in the explanation of the sequelæ of carotid ligations.

Comments—We see, then, that the obliteration of the common or internal carotid artery involves the consideration of conditions which do not obtain in ligations elsewhere.

Many ligations have been performed in the presence of conditions which we now recognize as contra-indications. Low blood-pressure, shock, anæmia, sepsis, and debilitating disease constitute contra-indications in ligations of election, but are necessarily disregarded in the emergency situations of hæmorrhage, extension of a hæmatoma, or the development of acute dysphagia or dyspnœa.

Recognizing that ligation of the common carotid reduces the volume flow in the internal carotid by approximately 50 per cent only, it is obvious that

ligation of the common carotid constitutes a partial ligation of the internal carotid. There would appear to be no necessity therefore, for the procedures of gradual throttling or fractional ligations of the common carotid by the use of special clamps or strips of fascia. It is obvious, also, that ligation of the internal carotid reduces the volume flow of blood to the brain to a greater extent than does ligation of the common carotid. When the internal is ligated primarily, the reduction in volume flow may be in itself sufficient to produce symptoms. It would be particularly likely in the presence of an arteriosclerosis that involved the intracranial vessels.

Since the demonstration, furthermore, that the mechanism of the carotid sinus exists in the bifurcation of the common carotid, we are made aware that ligation of the internal carotid carries with it an additional hazard. By increasing the pressure in the bifurcation back of such a ligature, the depressive action of the carotid sinus is increased. The ligation of the internal carotid, therefore, not only results in a greater reduction in the volume flow of blood to the brain but also produces a greater shock to the cardiovascular equilibrium.

Our present procedure is ligation of the common carotid and, if the reduction in volume flow in the internal carotid be insufficient, secondary ligation, after an interval of a week or ten days of the branches of the external carotid, never entirely abolishing the flow through the internal carotid unless we find it necessary after the other ligations have been tried.

The commonly held conception that obliteration of a vessel is accomplished by the formation of a clot which fills the vessel lumen as far as the next branch vessel is the result of Virchow's teachings⁶⁸ which have held so prominent a place in pathology.

Rokitansky⁶¹ taught the facts which we now know to be true, namely, that the obliteration of an artery is not dependent upon the formation of a thrombus. His opinions, however, were submeiged by those of his more prominent contemporary. While Rokitansky is accredited with the first teachings of these facts, I should like to place on record recognition of the name of Benjamin Travers⁶⁵ by quoting excerpts from a paper he read in London on October 26, 1813.

To ascertain with precision the effects of ligatures of various sizes, I have repeatedly examined the appearances left upon the cuticular coat of an artery after applying them, and the following is a report of such experiments upon the carotid, iliac, and femoral vessels of the human subject.

TRAVERS' EXPERIMENTS

Broad tape	no distinct impression but a general
Narrower tape	longitudinal puckering of inner coats especially opposite the knot
Narrow tape	the same with partial laceration
Narrower tape	cuts with fretted edge or partly cuts and partly tears
Flat bobbin	the same
Large round bobbin	cuts cleaner

Twist	clean and narrower incision
Twine	the same
Round ligature including sheath of linen upon the artery	faint but distinct incision
Round ligature, including cylinder of quill, wood, or other firm substance	deep but partial incision

It being established that the internal coat of an artery is prone to take on adhesive inflammation and that it is by virtue of this inflammation that the vessel can be permanently obliterated, it is not a question of difficult solution whether the mere apposition of sound surfaces, or the apposition of bruised and lacerated surfaces, or the apposition of fresh cut surfaces is the condition most favorable to union

Mr Hunter and surgeons after him were in the habit of applying the ligature with force only sufficient to bring the sides of the vessel in contact and some included an extraneous body, as a piece of cork or wood or a roll of linen to prevent the lesion of the artery in the act of tightening the ligature. The fear of cutting the coats of the vessel was uppermost in the minds of all. Scarpa and other eminent surgeons of the continent are still fettered by these fears. But we see that they are groundless, that on the contrary, the security and effect of the ligature are insured by its cutting the middle and internal coats, which it does without damage to the outer, however applied.

In all our experiments, the blood as blood has no concern in the obliteration of a vessel. A coagulum does not adhere to the inner coats of a vessel and could never be competent to permanently obstruct the canal of an artery. Experiments during the past five years confirm these observations of Travers, and could scarcely be summarized in fewer words.

The evidence that even an aseptic necrosis of a vessel wall may provide the essentials of thrombosis formation indicates that all unnecessary trauma to the vessel wall should be avoided. It would indicate that moderately sized round silk ligatures should be used, and tied singly, catgut being used only in an infected wound. It would indicate the avoidance of crushing of the vessel by clamps before the ligature is applied, and the exclusion from contact with the vessel of all foreign bodies, such as the aluminum bands of Halsted,²⁷ and Matas,⁵⁰ and the Neff⁵⁵ clamp. It would indicate the inadvisability of using the bands of fascia, Bier's membrane, *etc*, which have been shown by Pearse⁵⁶ to produce pressure necrosis. In a vessel the site of atheromatous degeneration, it would suggest that the preliminary compression of that vessel against the transverse process of the sixth cervical tubercle may so damage the vessel as to favor thrombus formation after ligation.

It has been shown that an aneurism of the internal carotid in its intracranial course in the treatment of which periods of preliminary compression are almost routine is a powerful natural stimulant of collateral circulation. Emile Holman³⁰ has very adequately demonstrated this fact. It would seem, therefore, that compression of the carotid preliminary to ligation is not only tedious and painful but unnecessary and apt to cause damage to the vessel to be ligated.

Wound infection having been seen to result more frequently in secondary hæmorrhage than in thrombus formation, we drain the wound in the neck, in

the presence of infection in the mouth or nose or throat, not in fear of thrombus, but to avoid secondary hæmorrhage. The wisdom of draining operative wounds in the neck, first taught by Billroth, was amply confirmed during the World War. It is an established practice with those who at that time saw many war wounds of the face and neck, but does not seem to have been adopted so widely as its value merits.

During the past few years in operating upon considerable numbers of mouth and face conditions, we have found it necessary or advisable to ligate an external carotid artery very frequently. Our experience is that the vessel may be ligated at any point in its course with no serious consequences, providing care is observed with regard to drainage, the use of properly sized ligatures, and the avoidance of unnecessary trauma.

Stimulation of the cervical sympathetic nerves, in the sense that such stimulation produces a vasoconstriction of the homolateral half of the brain, would appear to play no more than a minor rôle in the production of cerebral symptoms, if it plays any rôle at all.

The subjective symptoms constituting the reaction to common or internal carotid ligations are those of depression and the objective phenomena are those of cardiovascular inhibition. These phenomena of depression would seem to contain the answer to the question as to whether or not the internal jugular vein should be ligated at the same time as the carotid artery. Ceci⁹ recommended this manœuvre on the basis of two operations, in one of which he ligated the carotid alone and had the ligation complicated by cerebral injury, in the other he ligated the internal jugular along with the carotid and no symptoms followed. He reasoned that ligation of the jugular prevented a certain amount of blood from draining out of the cranial cavity and thereby avoided cerebral anæmia. We accept today Barney Brooks's⁶ explanation that ligation of the satellite vein, when an artery is ligated, is beneficial in the extremities, not by retaining greater volumes of blood in the extremity, but by causing a more even distribution of the small amount which is present. The brain, however, has been shown to possess highly specialized facilities for the even distribution of the blood. The brain requires oxygen at high tension even though it does not deprive the blood of any great amount of that oxygen. It is not the total volume of blood in the cerebral vessels which determines the proper nourishment of that organ, but the proportion of arterial to venous blood. It is important for the brain that venous blood be returned to the right heart for aeration in the lungs, and any obstruction to that return of blood to the right heart decreases the volume of arterial blood available for return flow to the brain. Since jugular ligation would tend to produce a certain degree of stagnation, we believe that simultaneous ligation of the jugular cannot be approved.

CONCLUSIONS

(1) Cerebral symptoms consequent to ligations of the carotid vessels are usually associated with, and result from, sudden extreme reductions of

systemic blood-pressures. These reductions in blood pressures are produced by the reactions of the carotid sinus mechanism, and most frequently occur following ligation of the internal carotid.

(2) A moderate percentage of complications are due to the reduced volume flow of blood to the brain.

(3) A small percentage of complications may be due to thrombosis and embolism.

(4) Intracranial arterial constriction due to stimulation of the cervical sympathetics does not play any part in the causation of these cerebral symptoms.

(5) Ligation of the common carotid artery reduces the volume flow of blood in the internal carotid artery by about 50 per cent. only.

(6) Almost 50 per cent. of the retrograde flow from the external carotid is derived from the superior thyroid.

(7) Common carotid ligation is a much less hazardous procedure than ligation of the internal carotid.

(8) Cerebral complications following carotid ligations may be lessened by

(a) Ligation of the common carotid with subsequent ligation of the branches of the external trunk. If this is not sufficient, ligate the external trunk itself and the internal trunk consecutively, thereby avoiding primary ligation of the internal trunk.

(b) The establishment of careful observation of the blood-pressure during the operation of ligation, and with adrenalin, or infusions, or in the anæmic with transfusions, combating promptly any marked persistent reductions of blood-pressures.

(c) The avoidance of those factors such as the compression of the artery before ligation, the use of clamps, fascial or metal bands, and coarse or redoubled ligatures, which have been shown to influence the deposition of thrombi.

By experience therefore and by experimental evidence, we believe we have established the principle that primary ligation of the internal carotid is fraught with danger, and that the practice of primary ligation of the common carotid, with later ligation, if necessary, of branches of the external carotid, should be adopted.

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ASYMMETRICAL BREAST DEFORMITIES

BY JACQUES W MALINIAK, M D

OF NEW YORK, N Y

FROM THE SYDENHAM HOSPITAL OF NEW YORK

PERFECT symmetry of the breasts is virtually non-existent. In practically every woman careful examination would reveal a slight variation in the size or shape of the mammae. Sometimes the asymmetry consists of minor differ-

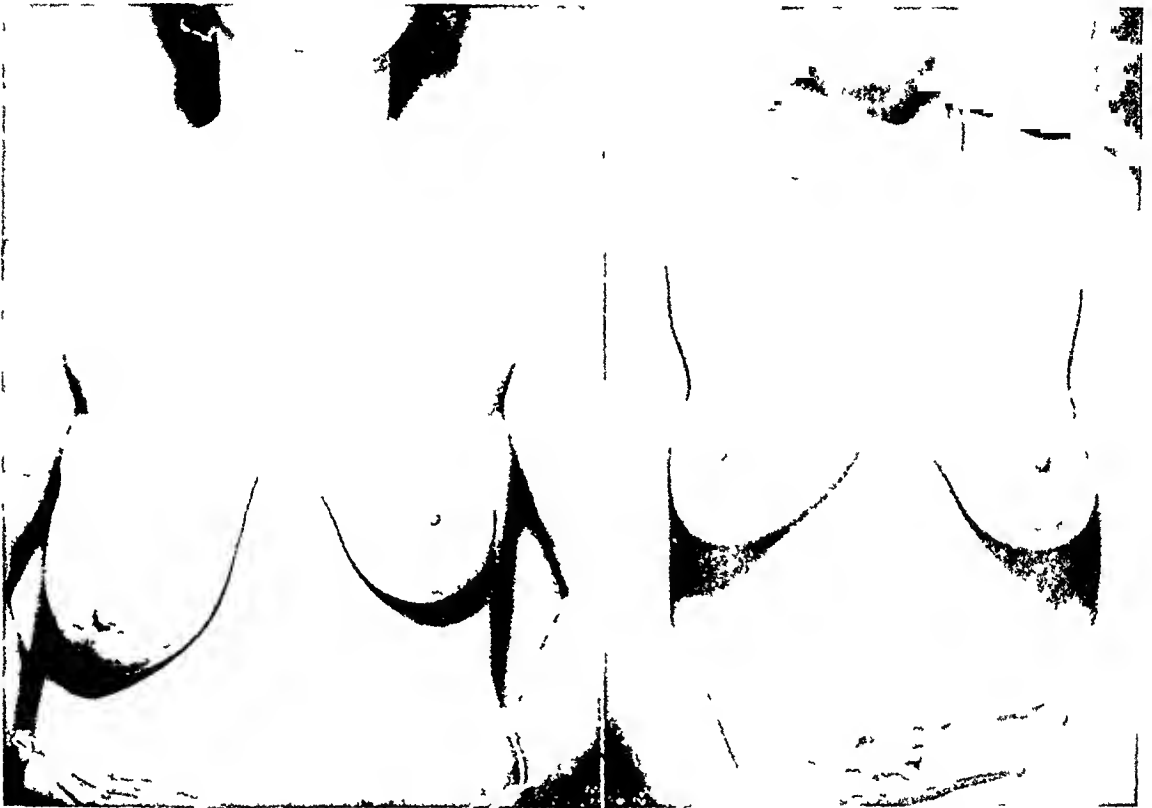


FIG 1A

FIG 1B

FIG 1A—Woman, aged thirty seven, married. Unilateral hypertrophy and asymmetry of the right breast. Asymmetry first noticed at the age of twelve when menstruation started and the right breast began to increase conspicuously in size. No other abnormalities in the general sphere. Following two pregnancies, the enlargement and ptosis of the right breast were disproportionate to the changes in the left. Because of the poor quantitative and qualitative value of the milk, breast feeding was discontinued after a few weeks. Heredity with reference to breast absent.

Examination revealed the right breast to be pendulous and twice the size of the left, which was normal in size but drooping. The right areola also was about twice the size of the left. The patient had been distressed for many years because the breast deformity prevented her from wearing proper clothes and necessitated artificial devices (padded cotton) over the left breast to establish the symmetry of the chest.

FIG 1B—Surgical repair consisted of reduction of the size of the right breast and areola, with transposition of the nipple, according to the pattern of the left breast which was not touched. Because of the shortness of the anterior skin flap the areola was made smaller than on the opposite side. A skin flap taken from the posterior aspect of the breast made up for the shortness of the supra areolar flap (Fig 6, 1H). This placed the scar above the submammary fold. No secondary modeling of skin and subcutaneous tissue was done as the patient was entirely satisfied with the result obtained.

ences in the areolæ and nipples. Sometimes the proportions of the entire hemisphere of the breast on one side fail to agree with those of its neighbor. Whatever the point of divergence, a slight asymmetry is a common occurrence. It generally manifests itself at puberty when the rapid development



FIG 2A—Girl aged twenty referred in August 1931, with unilateral right breast hypertrophy and ptosis. Asymmetry became noticeable at early puberty. Except for breast malformation and a slight protrusion of the thoracic wall on the affected side, general physical examination was negative. The right breast was about twice the size of the left and markedly pendulous, extending to a level of about three fingers above the umbilicus. The left breast was approximately normal in size but moderately pendulous. The right areola was about twice as large as the left which was also oversized.



FIG 2B—Surgery consisted of unilateral repair of the hypertrophic breast by transposition of the reduced areola and gland. Because of the shortage of skin covering caused by the excessive size of the areola, the lower incision had to be placed above the submammary fold (Fig 6 IH). This permitted the lower portion of the gland to be covered by skin from the posterior aspect of the breast.

The mental attitude of the patient improved greatly after the successful surgical repair. To satisfy her increased ambition correction of a nasal deformity was performed in a later stage.

of the mammæ starts. As a rule women are unaware of any difference unless it is pronounced enough to be noticeable when they are fully clothed. Minor variations are clinically as well as subjectively unimportant. Only conspicuous abnormalities will be considered in this paper.

Although pronounced asymmetries of the breasts occur with relative frequency, little has been published on the subject in the medical literature. A false impression of rarity is thereby created, abetted in part by the hypersensitiveness of patients with regard to this condition and their reluctance to discuss it frankly, even with their family physician. In the past year I have operated on five such cases, indicating that deformities of this type are more common than we have been accustomed to think. All of these cases (which included a rather unusual one of micromastia) differed in their morphological abnormalities. On the whole, they were fairly representative of the following classification.

Pronounced asymmetries of the breasts divide themselves into four main types.

(1) Asymmetry due to unilateral hypertrophy, with the opposite side apparently normal (Figs 1 and 2). (2) Bilateral asymmetrical hypertrophy (Fig 3). (3) Asymmetry due to unilateral underdevelopment or underdevelopment. (4) Asymmetry caused by a reversed development of the two breasts, such as hypertrophy on one side and underdevelopment on the other (Fig 4).

The first group, which is the most frequent, enjoys many degrees. Those rare cases which comprise the third and fourth groups are characterized by the utmost conspicuousness. In all categories, the use of the term "normal" must be taken with a grain of salt. Whatever the nature or extent of the asymmetry, the supposedly normal breast rarely lives up to its name. Usually there is a greater or lesser degree of ptosis present, supplemented, in many cases, by an abnormal configuration of the nipple and areola.

Etiology—In all of my cases the asymmetry manifested itself in early adolescence and increased with age. Three of the patients were young girls, ranging in years from eighteen to twenty-four. Two were married women, aged thirty-seven and forty, respectively. What are the causes of the malformations they presented?

It is a prevalent belief that in asymmetrical hypertrophies the larger breast is more common on the left side. The reason advanced for this alleged phenomenon is that right-handed mothers, who are in the majority, prefer to feed their infants with the left breast. My observations do not bear out this supposition. In four out of my five cases the hypertrophy was on the right side. Furthermore, three of the patients were young girls who had never borne children. Obviously we must look further for etiological factors.

Normally the physiological and anatomical changes occurring in the breast at puberty are influenced by hormones of internal secretions. It is readily conceivable that the development of the breasts can be accelerated or retarded by an excess or deficiency of these hormones. This would explain a bilateral

over- or underdevelopment It does not account clearly for unilateral abnormalities

The part that pre-natal maldevelopment plays in breast asymmetry is still to be proven, although there is considerable evidence in favor of this theory It is easy to believe that underdevelopment (micromastia) or a complete lack of development (amastia) is caused by a disturbance of the embryonal germ Usually these extreme types of mammary malformation are associated with



FIG 3A

FIG 3B

FIG 3A—Girl, aged twenty three, referred in December, 1932 with bilateral asymmetrical breast hypertrophy and ptosis General condition otherwise normal Both breasts were considerably oversized and asymmetrical at sixteen years and the patient was compelled to wear tight brassieres to conceal the deformed chest During 1932 both breasts had increased notably in size, particularly the left one The physical discomfort occasioned by their weight became almost unbearable pain in the left breast and traction on the shoulders interfered to a great extent with the patient's professional activities Family history with respect to mammary negative

Examination revealed both breasts greatly enlarged the left much more so than the right The left breast was abnormally distended, the glandular tissue hard nodular and painful on pressure There were no clinical signs of malignancy A pathological examination of specimen taken from a nodule of the left breast showed the condition to be a cystic fibroma

Because of this pathology and the marked hypertrophy, the surgical repair was done in two stages The glandular tissue, particularly that of the left breast, contained multiple encapsulated fibromas

FIG 3B—Condition four weeks after plastic repair of the larger left breast Repair consisted of transposition of areola and nipple and extensive excision of breast tissue

other abnormalities of the cutaneous, muscular and osseous tissues of the thoracic wall and the upper extremity (Fig 4) Frequently there is a correspondingly deficient development of the reproductive organs, especially the ovaries These associated maldevelopments are usually absent in the common forms of asymmetry, although in two of my cases there was a definite deformity of the thoracic wall directly under the larger breast In one

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instance this served to aggravate the deformity as the thoracic malformation further projected the larger breast

Trauma may be a contributing factor in the undue development of the larger breast as a result of efforts to conceal the malformation by excessive pressure. All of my patients admitted that they had been extremely sensitive on the subject of their mammary abnormality from early adolescence and had tried to produce apparent symmetry by the use of tight brassieres

In one case (Fig 3) cystic fibromas were responsible for a rapidly increasing bilateral asymmetrical hypertrophy. In another (Fig 4) congenital underdevelopment of one breast was accompanied by a pronounced hypertrophy of the other with malformation of the thoracic muscles and the upper extremity on the same side

Hereditary factors were ascertainable in only one case. In the two married women the dimensional reaction of both breasts to pregnancy had been approximately normal. Both mammae had increased substantially in size and then later contracted again. Lactation had not been possible in either case because of the quantitative and qualitative insufficiency of the milk

Surgical Repair—The indications for repair depend on the degree of asymmetry, the age of the individual and the extent of her mental and physical reactions to the deformity. No one of these factors can be considered independently of the others. Where participation in sports is barred by the malformation or evening clothes and bathing suits cannot be worn, it is easy to understand the request for relief from a deformity which is physically and mentally oppressive. Two of the patients described in this article were women of past middle age, married and with mature children when I operated on them. In spite of the many years during which they had had an opportunity to become adjusted to their condition, they were still anxious to be relieved of a defect which had caused them unceasing distress

In bilateral hypertrophy the size and weight of the breasts often cause great physical discomfort which is aggravated by the difficulty of adjusting the condition to the demands of present-day dress. The asymmetry of the chest, which can be concealed only by cumbersome artificial devices, adds to the conspicuousness of the malformation

When one side is apparently normal or is not noticeably large and pendulous (Figs 1 and 2) the indication is for unilateral repair. The oversized breast is reduced to correspond in size and position with the other. When, in addition to an asymmetry, hypertrophy and ptosis characterize both sides, bilateral reconstruction is indicated as the only procedure which will adequately correct the deformity and satisfy the patient

The procedure of choice for the repair of these malformations embraces transposition of the reduced gland and nipple with window resection for insertion of the areola¹. Surgery is more elaborate than in the symmetrical deformities because the abnormal breast must be made to correspond in size and position with the opposite side. In bilateral malformations the measurements adopted for the reconstruction are arbitrary and equal on both sides

In unilateral repair, on the other hand, the operated breast must harmonize in size and form with its supposedly normal mate. This is particularly difficult when the latter is partly pendulous and has an abnormally large areola. A larger breast must then be reconstructed than would be necessary if surgery were bilateral. If the diameter of the areola is excessive, there is apt to be a shortage of skin covering as the anterior flap must not encroach upon the pigmented area and the breast must be made to correspond in size to the

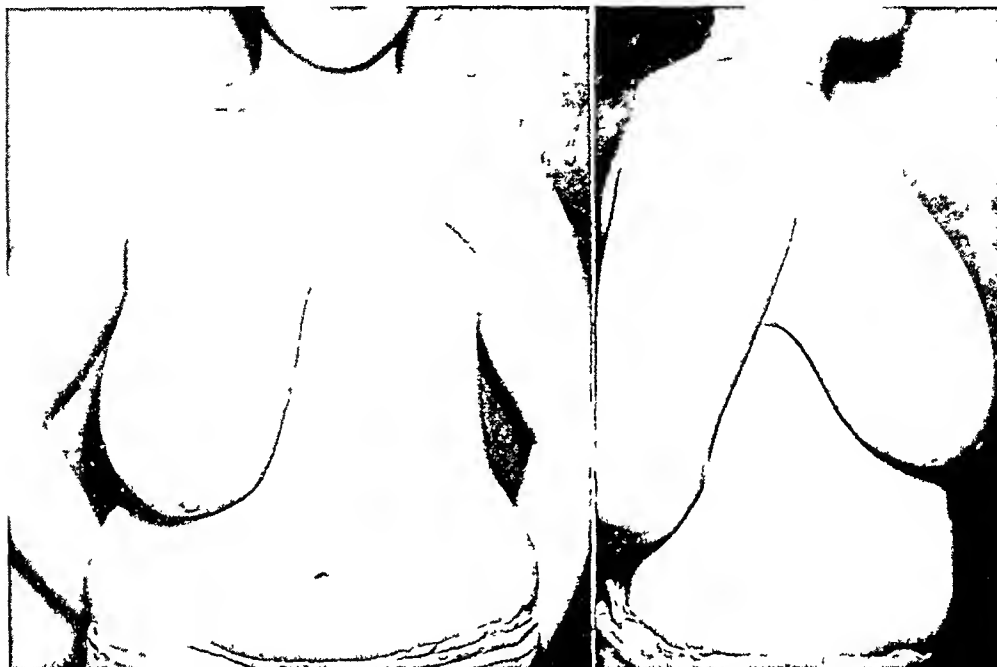


FIG 4A—Girl aged eighteen referred in May, 1932 with pronounced asymmetry of the chest caused by a reversed development of the two breasts: micromastia on one side and hypertrophy on the other. Asymmetry noticed by the mother when the child was a few months old. Already at that time the left side of the chest and back appeared flatter than the right and the left upper extremity was shorter than the right. The birth of the child and subsequent development had been normal except for the malformation noted. Menses began at the age of twelve and were irregular, prolonged and painful. The patient was always overweight; she was heavily built and appeared much older than she was. Except for the disturbance in the functioning of the sexual organs and the marked sensitiveness in regard to the chest deformity, her condition appeared to be normal. Family history with reference to breast negative.

Examination revealed the left breast to be represented by an underdeveloped gland of infantile type with a nipple and areola faintly outlined. The entire left side of the chest was underdeveloped in all dimensions and the pectoral muscle was absent except for the clavicular portion. The muscles of the back were underdeveloped. The shoulder and the entire upper extremity of the left side were shorter than on the right. The right breast was very hypertrophic and pendulous with an areola many times the size of normal; it reached a level of about two fingers above the umbilicus. Because of the infantile type of the left breast, subtotal amputation of the right breast with free grafting of the areola was advised, as it would be impossible to reduce the right breast to correspond in size to the left. The patient and her family objected to this procedure and it was decided to reduce the right breast in successive stages and enlarge the left side of the chest by a fascia fat graft. (A full report of this case with final end result will be published separately.)

opposite side. Matching the position of the nipples is another delicate task in unilateral repair. Throughout the latter difficulties are encountered that are not present in bilateral reconstruction, as a result of the necessity to conform to a pattern which is usually far from ideal.

To attain symmetry, both breasts should be exposed during operation and the excision of fat and glandular tissue should be governed by constant comparison in all diameters. It is often necessary to affix the gland to the pectoral fascia to achieve parallel position and the desired shape.

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In choosing the method of repair the surgeon must be guided by the ultimate form of the breasts.² Some procedures are apt to produce an excessive protrusion which contrasts unfavorably with the slight pendulousness which is usual on the opposite side.³

Dangers of Necrosis—Because of the scarcity of skin there is a tendency to submit the transposed nipple to excessive tension, thus endangering the blood supply. Cyanotic discoloration of the areola, occurring immediately after the nipple is sutured into its new position, is a warning to relieve tension without delay. During the post-operative period venous stasis may be caused by hematoma. Cyanotic discoloration of the pigmented area the day after operation may point to this complication. To prevent it drainage should be



FIG 4B—Following second stage of repair by the method of transposition of the nipple and extensive excision of breast tissue

instituted at the time of operation by means of rubber drains which are removed after twenty-four hours.

Excision of too much glandular structure at one time may also result in interference with the blood supply, especially during the reduction of a markedly hypertrophic breast (Figs 3 and 5). The excessive removal of tissue in one stage is particularly dangerous on the sides, where the main blood supply, provided by the mammary artery on the inside and the thoracic lateral on the outside, may be cut off from the remaining gland to a considerable extent (Fig 6, III). To prevent this contingency, it is advisable to carry out the surgical procedure for the reduction of marked mammary hypertrophy in two stages. At each operation either the external or the internal portion of the gland is left intact to preserve part of the main blood supply. This precaution eliminates the danger of sloughing of the skin or nipple (Fig 6, IV and V).

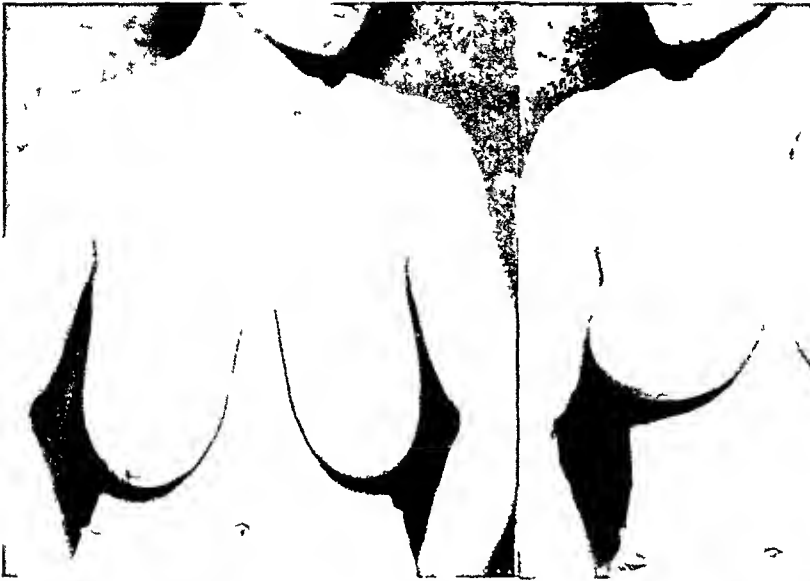


FIG 5A



FIG 5B



FIG 5A



FIG 5B

FIG 5A—Girl aged twenty seven referred in May 1932 for plastic repair of hypertrophic pendulous breasts extending to a level slightly above the umbilicus. Due to the *symmetry* of the deformity, the outlining of incisions could be made equal on both sides to approach an ideal pattern. The surgical repair was done in two stages. In the first, skin flaps were outlined on both breasts and excessive fat and glandular tissue removed, especially in the lower poles (Fig 6 III). The transposed areolae were sutured at a higher level without undue tension. Interference with the blood supply was avoided by preserving most of the glandular tissue on the lateral sides of the breasts. Three months later the redundant skin and glandular tissue were removed from the external aspect of the breasts through an incision in the submammary folds (Fig 6, V H).

FIG 5B—End result with the areolae sutured securely visible and the lower incision concealed in the submammary fold. The satisfactory end result brought about a great improvement in the physical and mental attitude of the patient.

When the skin covering cannot be provided in its entirety by the anterior flap without producing tension about the nipple the posterior incision is placed above the submammary fold, thereby making it possible to utilize part of the

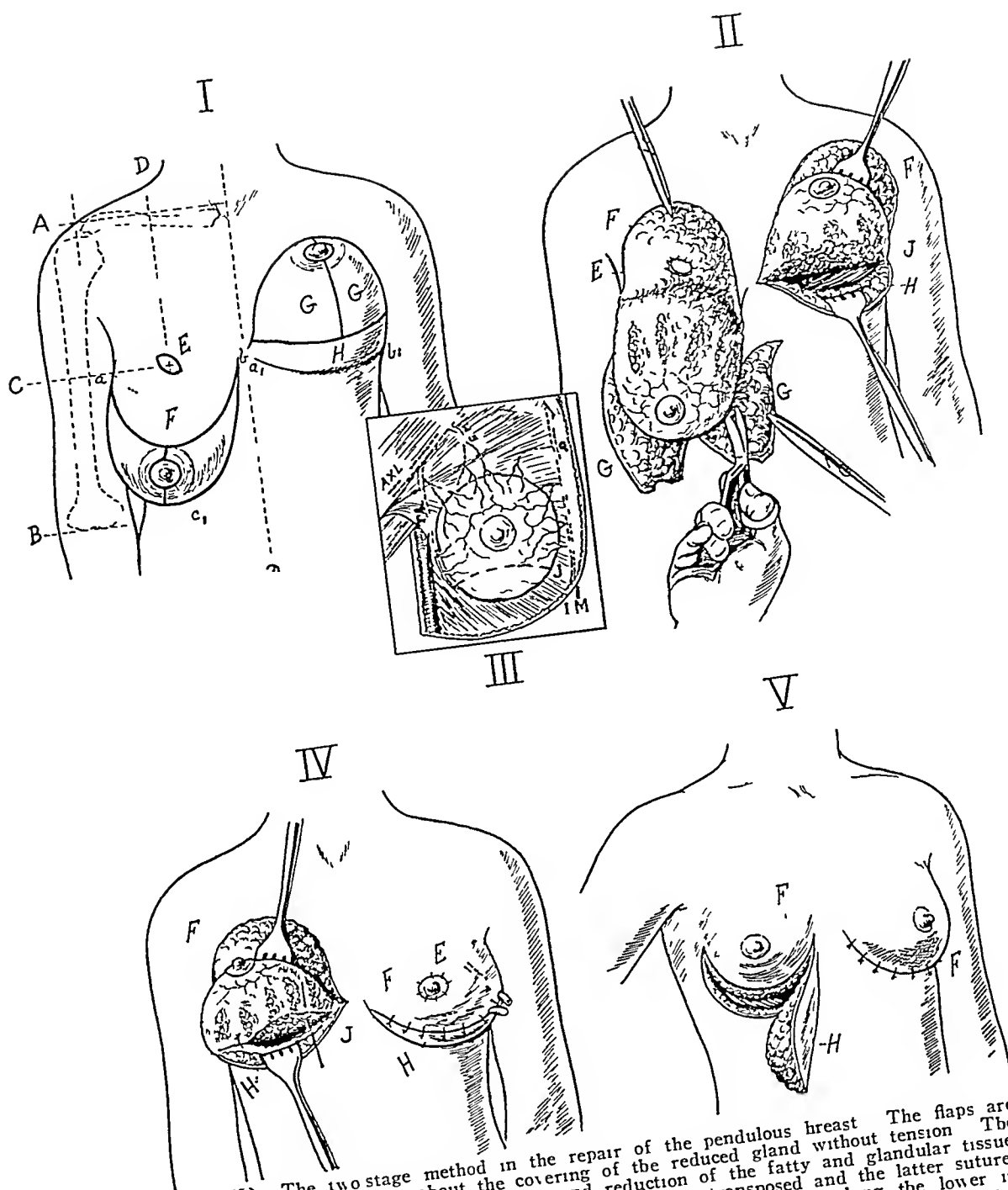


Fig 6—(I) The two stage method in the repair of the pendulous breast. The flaps are outlined in such a way as to bring about the covering of the reduced gland without tension. The first stage consists of the excision of excessive skin and reduction of the fatty and glandular tissue, particularly in the lower pole. The reduced gland and areola are transposed and the latter sutured into a window previously prepared as the new location for the nipple. By making the lower incision above the submammary fold (a, h), additional skin is made available on the posterior aspect of the breast (H), to cover the gland without tension. This reduces the danger of necrosis to a great extent. (A) Horizontal line across the clavicle (B) Horizontal line through elbow joint (C) Horizontal line halfway between A and B (c) Circular incision reducing the size of the areola (D) Vertical line across the middle of the clavicle (E) Intersection of C and D which determines the new location of the nipple (F) Anterior flap, the lower border of which extends to the areola (G) Excessive skin on lateral and posterior aspect of the breast to be excised (H) Skin flap above the submammary fold to be sutured to flap F (a b) Submammary fold

(II) Shows denudation of the gland, excision of lateral flaps (G) and removal of fat and glandular tissue from the lower pole (J). This is done only superficially in the upper and lateral quadrants. Note that the blood supply around the reduced nipple is retained.

(III) Shows the main distribution of the blood supply in the breast gland. The thoracic lateral (T L) and external mammary (E M) branches of the axillary (A X L) supplying the serratus anterior muscle and sending perforant branches through the external portion of the gland and skin. Internal mammary (I M) and perforant branches to the deeper portion of the gland and the skin on the inner third of the breast (a) Main intercostal artery which passes to the second intercostal space.

(IV) Showing reduced gland after excision of all excessive skin during closure of glandular defect (right breast). Left breast, after transposition of the areola and the suturing of skin flaps H and F.

(V) (Second stage) Right breast shows removal of excessive skin, fat and glandular tissue by a crescent shaped excision along the submammary fold. The hypertrophic glandular structures in the external quadrant can now be freely excised without danger of impairing the vitality of the nipple because healing of the latter has been achieved in the first stage. Left breast, final condition after closure of the defect.

skin from the posterior aspect of the breast¹ The disadvantage of this lies in the fact that the linear scar is then visible under the areola instead of being concealed in the submammary fold (Fig 2) Sometimes a shortage of skin covering makes it necessary to transpose a smaller areola than that of the opposite side This is a minor imperfection

Summary—The most frequent varieties of breast asymmetry are (1) asymmetry due to unilateral hypertrophy, with the opposite side normal, (2) bilateral asymmetrical hypertrophy, (3) asymmetry due to unilateral amastia or micromastia, and (4) asymmetry caused by reversed development of the two breasts Bilateral asymmetrical hypertrophy is the commonest type and occurs in young girls as well as married women

The etiological factors are not yet known Embryonal maldevelopment is to be suspected when malformation is present in the chest-wall, the upper extremity and the organs of reproduction Disturbances of internal secretion during puberty are probably the cause in a number of instances Trauma may be a contributing factor in the overdevelopment of the larger breast because of the attempt to conceal the asymmetry by excessive pressure

The indications for surgical repair depend on the degree of asymmetry and the age of the individual Unilateral repair is indicated when only one breast is conspicuously enlarged If the opposite side is also partly deformed, correction should be bilateral Surgical reconstruction is more elaborate in unilateral than in bilateral symmetrical hypertrophy because of the necessity to make the deformed breast correspond in size and position with the opposite side

The procedure of choice for the repair of these deformities is transposition of the reduced gland and nipple Necrosis of the skin and nipple are prevented by avoiding interference with the main blood supply such as results from excessive removal of glandular tissue in one stage, the formation of hematoma or undue tension

The plastic repair of markedly hypertrophic breasts is best done in two stages to avoid complications and assure a satisfactory cosmetic end-result

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TUBERCULOSIS OF THE BREAST¹

BY WALTER ESTELL LEE, M D , AND W RUSSEL FLOYD, M D
OF PHILADELPHIA, PA

FROM THE SURGICAL SERVICE AND THE PATHOLOGICAL DEPARTMENT OF THE GRADUATE HOSPITAL OF THE
UNIVERSITY OF PENNSYLVANIA

UNTIL the observations of Sir Astley Cooper¹ in 1829, the human breast was considered as being immune to tuberculosis. Even after this lucid description, tuberculosis of the breast was a much disputed entity and not generally accepted until 1881, when Dubai,² by microscopical methods, proved the breast to be subject to tuberculosis.

Compared with the frequency of tuberculosis occurring in the other organs of the body, mammary tuberculosis is apparently a relatively uncommon condition. Out of 2,297 cases of diseases of the breast, Malloy³ found only 0.6 per cent to be tuberculous. In the decade between 1904 and 1914, Deaver⁴ found only seventy-four proven cases of mammary tuberculosis. Barker,⁵ in 1926, found that tuberculosis of the breast occurred once to each fifty cases of carcinoma of the breast.

Tuberculosis of the breast is of course due to the tubercle bacillus. Barker⁵ claims that all cases in which the organism was recovered were due to the Bovine type. This, however, has not been studied in a large enough series of cases to draw any definite conclusions. It is interesting to note that, according to Boyd,⁶ tuberculosis is common in the udder of the cow.

Trauma does not seem to play a very important rôle as a predisposing cause, as only 7 per cent of the cases gave any such history. Heredity apparently also plays a minor rôle as a predisposing factor as only 13 per cent of the cases gave a history of tuberculosis in the family.

Sex is a predisposing factor as out of 399 cases of breast tuberculosis in only fourteen was the breast of a male involved. Age is important as the majority of the cases occur between the twentieth and fortieth years, the period of reproductive activity. Two hundred ninety-four cases were married and 188 had borne children. The youngest case observed was that of a male child six months old and the oldest case was that of a woman aged seventy-three.

There is considerable controversy in regard to the manner in which this disease is contracted. The cases are grouped as primary mammary tuberculosis, in which the only evidence of tuberculosis is in the breast, and as secondary mammary tuberculosis, in which the disease is secondary to an existing tuberculous infection in other organs. Of the 399 cases of mammary tuberculosis on record, 234 were classified as primary, as no other evidence of tuberculosis could be found.

Deaver and MacFarland⁷ state that with the exception of the few instances of direct inoculation of the breast, through abraded surfaces of the nipple or skin and possibly

* Read before the Philadelphia Academy of Surgery, November 6, 1933.

through the milk ducts, all mammary tuberculosis may be looked upon as a secondary manifestation of the disease

Gatewood⁸ believes that tuberculosis of the breast is similar to tuberculosis of the kidney in that there is usually a primary focus of infection elsewhere in the body whether or not it can be discovered by clinical methods. Morgen⁹ states that the majority of investigators hold the most common route of tuberculous infection of the breast is by the blood-stream. He points out that the majority of people are infected with tuberculosis but not diseased, and he believes that through some lowering of local resistance around this area of infection, the organisms are liberated and may infect the breast through a retrograde lymphatic flow or by way of the blood-stream. Nagaskima,¹⁰ however, reports the autopsy findings in thirty-four cases of miliary tuberculosis of the disseminated type in which there was no evidence of tuberculosis in the breasts and he concluded that tuberculous infection of the breast by way of the blood-stream must be extremely rare as in his series the breast was the only organ not diseased. Tuberculous infection of the breast by contiguity is uncommon but may develop from a tuberculous empyema, involving the structures of the chest-wall and eroding into the breast itself.

Pathology—Tuberculosis of the breast is predominately unilateral, as out of 399 proven cases only thirteen had bilateral involvement. It occurs with about the same frequency on either side.

The pathology of mammary tuberculosis is best classified as follows: (1) acute miliary tuberculous mastitis, (2) nodular (discrete, disseminated or confluent), tuberculous mastitis, (3) sclerosing tuberculous mastitis, (4) tuberculous mastitis obliterans, (5) various atypical forms.

(1) Acute miliary tuberculous mastitis occurs in conjunction with generalized miliary tuberculosis and has no special surgical significance.

(2) The great majority of the cases of tuberculous mastitis are of the discrete nodular variety. The bacilli lodge in the mammary stroma rather than the ductile or periductile tissue and excite a localized tubercle formation. Daughter tubercles form at the periphery of the original focus and, in time, usually a matter of several months but sometimes longer, a palpable mass is formed. This varies in size but rarely exceeds that of a hen's egg. The process may progress from the discrete nodular type to the nodular disseminated or the nodular confluent type or on to sinus formation. Also, it may become encapsulated and lie quiescent for varying periods of time.

One does not see in the breast the abundant reticulo-endothelial reaction so characteristic of the disease in other organs. There is usually an extensive round-cell infiltration throughout the breast tissue in the region of the lesion and giant cells may be seen.

(3) The sclerosing type of tuberculous mastitis is a very slow progressive lesion and most frequently seen in elderly people. The breast is usually not enlarged and often there is retraction of the nipple due to the large amount of fibrous tissue formed. Sinus formation is rare in this type. Microscopically there is usually seen a diffuse lymphocytic cellular infiltration accompanied by epithelioid and giant cells interspersed with varying amounts of fibrous tissue but with very little caseation.

(4) In the tuberculous mastitis obliterans the lesions seem chiefly to surround the milk ducts, destroying the epithelial linings, and finally obliterating

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them The retained material in the obliterated ducts may excite the formation of foreign-body giant cells The nipple is sometimes ulcerated away and these cases seem illustrative of a primary ductile infection

Tuberculosis of the breast is sometimes associated with other diseases of the breast There are reported ten cases showing adenoma and seventeen cases showing a co-existing carcinoma In one of these cases there was bilateral breast carcinoma with unilateral mammary tuberculosis

Symptomatology—The clinical history of this disease is not characteristic in the primary cases In the secondary cases the findings elsewhere in the body of tuberculosis lead one to suspect the lesion In 75 per cent of cases the first thing noticed by the patient was a painless lump in the breast Only 6 per cent had pain for the initial symptom In the remainder of the cases the first symptom was discharge from the nipple, hardening of the breast or sinus formation

The physical findings depend upon the type of the disease and the stage There may be seen anything from a single cystic tumor in the breast to a breast reduced to a mass of puckered skin upon which open many discharging sinuses In some, there may be a retracted nipple, in others, the skin overlying the tumor may be pulled in or pushed out and may even resemble the pigskin appearance of carcinoma Upon palpation, the tumor may feel not unlike a malignant one being fixed to the surrounding tissue It is not encapsulated and the induration of the surrounding tissue may greatly resemble the oedema of the tissues immediately about an area of carcinoma In the sclerosing type of tuberculosis, one may feel nothing more than the hardened breast parenchyma without any localized lump If an unruptured abscess is present in the superficial part of the breast, fluctuation may be elicited and in the absence of signs of acute inflammation it cannot be differentiated from a simple cyst

There is axillary lymph-gland involvement in over 50 per cent of cases In general, tuberculosis of the breast runs a more acute course than does carcinoma of the breast though several cases are reported in which the tuberculosis was present in the breast for over five years and one case in which it was present for eighteen years

Diagnosis—The diagnosis of tuberculosis of the breast is made upon the history of a painless lump in the breast, slow in growth and in many instances going on to abscess, rupture and sinus formation The involvement is nearly always unilateral as only 13 out of the 399 proven cases were bilateral If active tuberculosis is present or has been present elsewhere the diagnosis of mammary tuberculosis is strengthened When there is only the lump in the breast, chronic cystic mastitis, fibroma, adenoma, papilloma, gumma, sarcoma and carcinoma must be ruled out The fibro-epithelial tumors and simple cysts will not as a rule excite suspicion of tuberculosis Gummas may be ruled out by the Wassermann reaction, and by anti-luetic treatment Sarcomas are very rare in the breast and grow with great rapidity Pain is usually present and the cutaneous veins over the breast are as a rule greatly dilated Cai-

cinoma may be extremely difficult to differentiate from tuberculosis of the breast. However, tuberculosis usually occurs at a younger age and as a rule runs a more acute course than carcinoma. Even in cases in which there is fluctuation one cannot rule out cancer as this tumor may undergo central softening.

Some cases of tuberculous mastitis of the sclerosing type cannot be differentiated from carcinoma by gross section and one must resort to microscopy. The roentgenograms of the breast will be of aid in diagnosis, although we can find no literature on the roentgenographical findings in mammary tuberculosis. The differential points would probably be somewhat the same as between carcinoma and chronic mastitis. The majority of the reported cases of primary tuberculosis of the breast were misdiagnosed as carcinoma and not until after operation was the presence of tuberculosis suspected. In mammary tuberculosis with sinus formation, simple pyogenic mastitis, degenerated gummas, actinomycosis and carcinoma must be ruled out. Simple pyogenic mastitis usually runs a more acute course than does tuberculous mastitis, though this is not always true. Broken-down gummas may be ruled out by the Wassermann test and by anti-luetic treatment. Actinomycosis is extremely rare and the ray fungus usually can be found in the discharge from the sinuses.

Carcinoma with sinus formation may resemble closely breast tuberculosis. However, as patients are paying more attention to lumps in the breast and are coming to physicians earlier, this stage of cancer is becoming rare. Curettement of the sinuses may disclose tuberculous granulation tissue and the Koch bacillus can sometimes be isolated from the discharge. On all cases of suspicious breast tumors carcinoma should be considered until ruled out. The absolute diagnosis of mammary tuberculosis is made by the microscopical finding of the tuberculous tissue in the lesion or curettings from the sinuses, rarely by the finding of Koch bacillus in stained sections, or the development of tuberculosis in animals inoculated with pus or scrapings from the lesion and more rarely by the finding of the organism in the pus. The tuberculin test is of little value in adults as practically all show a positive reaction.

Treatment—The treatment of breast tuberculosis is surgical removal of the lesion. There are no cases in which proven breast tuberculosis has undergone a spontaneous regression. Rontgenotherapy perhaps would be efficacious in an early lesion, though we can find no evidence of cases so treated. Some writers advocate simple mastectomy in all cases, while others are more conservative and recommend removal of the involved area only. Radical mastectomy with removal of the pectoral muscles is never necessary unless there is involvement of the chest-wall. The accompanying lymph-node involvement may be removed surgically or may be treated by rontgenotherapy. When mammary tuberculosis is untreated, the disease may attack other organs and cause death.

The prognosis in cases of primary breast tuberculosis with proper treatment is excellent, as the general health of the patients is nearly always good. This is not true of the cases of secondary breast tuberculosis, the prognosis

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being guided by the degree of tuberculous involvement in other parts of the body

CASE I—White female, aged fifty-nine, a housewife by occupation was admitted to the Graduate Hospital with an ulcerative lesion on both nipples. The past history was uneventful except for the birth of one child, now living and well, and the removal of a small benign growth from the upper portion of the left breast fourteen years before admission. There was no known contact with tuberculosis in any form.

Physical examination was essentially negative except for the presence of an ulcerative lesion on each nipple. Seven months prior to admission she had first noticed a crusting of both nipples. The lesion on the left breast progressed more rapidly than the one on the right and after several months the surrounding areola became involved. When the crusts were removed there was seen a raw bleeding surface, but there was



FIG 1—(CASE II) Photograph before operation showing large tumor in upper right breast with retraction of the nipple

never any active discharge from either nipple. There was a small area of induration beneath each nipple, more on the left than the right. No other pathology could be felt in either breast and the axillary lymph-glands were not enlarged.

Rontgenogram of chest showed an old organized lesion in the right upper lobe which was thought to be an old healed tuberculous process. Rontgenogram of the breasts showed a small area of density beneath each nipple, more on the left than on the right.

The pre-operative diagnosis was Paget's disease of nipples and both breasts were removed by Dr. Walter Estell Lee. Dr. E. A. Case reported both breasts to be tuberculous, the only involvement being a small area just beneath each nipple. Sputum was examined on six occasions and one guinea-pig was inoculated with sputum and no tubercle bacilli were found.

The patient made an uneventful recovery and six months after operation was in good condition with no evidence of recurrence of her tuberculous infection. This case would appear to be one of primary bilateral tuberculosis of the breasts, gaining entrance by way of the milk ducts.

CASE II—White female, aged thirty-four, a housewife by occupation, was admitted to the Graduate Hospital with a tumor in the right breast. Her past history was un-

eventful except for the birth of two children, two and five years previously. There had never been any known contact with tuberculosis. One week before admission she had first noticed a painless lump in the upper part of the right breast. There were several enlarged lymph-glands in the right axilla. The breast tumor (Fig 1) measured 6 cc in diameter and appeared to be nodular and infiltrating in character. There was no attachment to the chest-wall, but the attachment to the skin and the upper part of the nipple made it appear to be retracted. The lesion had none of the appearances of being inflammatory and was only slightly tender on palpation. There was never any discharge from the nipple. Rontgenogram of the breasts (Fig 2) gave evidence



FIG 2—Left breast normal. Note the regular striations extending downward from the nipple toward the base of the breast.

FIG 3—Right breast shows a general enlargement as compared with the left. The films were made under like conditions. There is a general dense area with a central portion which is specially dense. This is not sharply defined as occurs in a cyst, but radiates gradually into the surrounding tissue which led to the rontgenological diagnosis of carcinoma, but in review, December 5, 1933, one can recognize that there is a base line located about $\frac{3}{8}$ inch to $\frac{1}{2}$ inch from the chest wall, which should always make one think of a non malignant lesion, for the carcinomas break through this base line.

of an infiltrating tumor which did not appear to be encapsulated and seemed definitely invasive in character. Rontgenogram of the chest as well as other routine laboratory studies were all negative for disease.

A diagnosis of carcinoma of the breast with involvement of the axillary lymph-glands was made and operation advised. Operation was refused and under the direction of Dr. George E. Pfahler radium needles were placed in and around the lesion (Fig 3) and rontgenotherapy was given to the point of maximum skin tolerance. This therapy covered a period of three months and at the end of this time the lesion had become very painful and had increased in size, not responding to massive irradiation as does the usual

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breast carcinoma Operation, again urgently advised, was accepted and the patient returned to Dr W L Estes, of Bethlehem, Pa, who performed a radical mastectomy on the involved side The pathological examination, made by Dr Henry Rothrock and confirmed by Dr E A Case, was tuberculosis of the breast and axillary lymph-glands

The patient made an uneventful recovery from the operation and has been quite well since This would appear to be a case of primary mammary tuberculosis as no other evidence of tuberculosis could be found

CASE III—Negress, aged thirty-three, a housewife by occupation, was admitted to the Graduate Hospital with painful masses and discharging sinuses in the left breast and axilla The past history was not significant except for the birth of one child now living and well and the fact that she had never been in contact with tuberculosis

One year before admission she first noticed two small painless lumps in the left axilla About two months later these lumps began to enlarge, became painful and the left breast began to enlarge Several months before admission three sinuses appeared, one in the upper outer quadrant of the left breast, one in the axilla and one between the breast and axilla She was well nourished and the only evidence of disease was an indurated tender area extending from the upper part of the left breast to the axilla Three sinuses were present and large amounts of brownish-gray pus was being discharged

Rontgenogram of the chest showed an old fibrotic lesion in the apex of the right lung which was thought to be healed tuberculosis Cultures from the breast showed *Staphylococcus albus* A diagnosis was made of chronic suppurative mastitis and axillary lymphadenitis Dr Wm Bates removed the indurated sinus-bearing area in the breast and the indurated sinus-bearing area in the axilla The wound was partially closed with adequate drainage

The pathological examination of the specimen by Dr E A Case was tuberculosis of the breast and axillary lymph-glands The patient left the hospital on the eighteenth post-operative day with a small draining sinus and in good condition The wound was treated for several months in the out-patient department but failed to heal and a second operation was advised The patient refused and shortly afterward left the city and further records could not be obtained This case would appear to be one of mammary tuberculosis with sinus formation secondary to tuberculosis of the axillary lymph-glands

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VALUE OF NEPHROLYSIS, URETEROLYSIS AND NEPHROPEXY IN SELECTED CASES *

BY ALEXANDER RANDELL, M D , AND EDWARD CAMPBELL, M D
OF PHILADELPHIA, PA

AS THE gradually unfolding picture of our modern conceptions of renal pathology, with its surgery, becomes clearer to us, certain facts stand out in bold relief as playing very essential parts in the problems presented. One of the most evident of these is the part played by soil preparation, by which we infer that certain changes from the normal are existent and by their mere existence invite pathological sequelæ. One of the most frequently abnormal states to be recognized is faulty drainage, and a large group of pathological conditions are today gathered under this one heading and called the obstructive uropathies or, in the subject at hand, the obstructive nephropathies. Today rather than say that this kidney is pathological because of the presence of an infection, we should say that this kidney is diseased because it was primarily anomalous, or because its drainage was faulty. Perhaps chronic pyelitic infection illustrates the point in question. Everyone recognizes the occurrence of an acute pyelitis and, by such, accepts the clinical picture of an acute infectious process that runs its course and terminates—as all such self-limited infectious processes do—with a complete return to normal, but the chronic pyelitis, with recurring acute exacerbations that never completely clear up, is the one where some form of perverted function, faulty drainage, or abnormal renal anatomy has prepared a soil which, once infected, is incapable of ever again regaining its normalcy. Helmholtz, in his studies on chronic pyelitis, was able to prove the existence of a renal anomaly in one out of every three cases, while Roscher found 26 per cent of renal anomalies in 5,527 autopsies.

Similarly, the pathogenesis of renal calculus, in certain of its phases, is approaching an appreciation of the part played by soil preparation in its occurrence and especially in its re-occurrence.

These two conditions, chronic infection and stone formation, when observed in the lower urinary tract, are acceptable proof today of faulty bladder functioning, and are looked upon as symptoms of obstruction and no longer as disease entities. Does it not behoove us to transport this concept to the upper urinary tract and, by so doing, approach its problems along lines of acceptable and proven pathological reasoning?

We are presenting for your consideration forty-six selected cases of renal pathology, in each of which some form of unilateral obstructive nephropathy existed at the time of operation. It might have been proper to entitle this presentation under the older term of hydronephrosis, for,

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with but one exception, all the cases presented the picture of this condition, but the purport of this presentation is to leave this clinical approach, with its clinical diagnosis, and to present the picture from the point of view of the fundamental underlying cause, for in the rectification of such basic pathology lies the successful surgical approach and successful surgical handling

We have purposely excluded the cases of calculus obstruction, as the hydrodynamics of this condition are readily appreciated and generally understood

These forty-six cases will be discussed under the following headings (a) pathogenesis, (b) symptomatology, (c) diagnosis, (d) results, and (e) treatment

Pathogenesis—In thirty-six of the patients the operative lesion was on the right side, in one it was bilateral, and of the remaining nine cases, the lesion was in the left kidney. Two were in a solitary kidney, the other having been previously sacrificed. This prevalence of right-sided pathology, especially evident in renal ptosis, or acquired renal dystopia, has oftentimes been recorded and reasons for its occurrence surmised, yet so far we have not received a satisfactory explanation on which all can agree. The normal lower position of the right kidney, the presence of the liver above, the greater mobility of the hepatic flexure as compared with the splenic flexure of the colon, the greater muscular exertion in the right-handed, the proximity of appendiceal infections, and the part the physiological function of pregnancy plays, are all probable factors in selected cases and can be potential factors in the unilateral soil preparation.

The pathological lesions found to explain the cause of symptoms and signs in this series were as follows. In nine cases aberrant lower polar vessels were the cause of the obstructive nephropathy. In twenty-two cases acquired renal dystopia was at fault. In thirteen patients a peri-ureteritis was present, while in the remaining two cases a true stricture, or submucous fibrosis, was present at the ureteropelvic junction.

Anomalies—In seventeen of these forty-six cases true renal anomalies were demonstrable. Some were anomalies of position, as faulty ascent or rotation, others anomalies of form, such as the pancake or disk kidney, while others presented true anatomical anomalies, such as varying degrees of bifid pelvis and ureters, or true anomalous blood vessels.

It is interesting to record these anomalies though difficult to faithfully ascribe to them their true rôle in the obstructive nephropathy. However, in nine cases accessory aberrant lower polar vessels were demonstrated and adjudged to be the active obstructing factor. The *post hoc, propter hoc* argument, as regards the finding of an aberrant lower polar vessel, is not always acceptable proof of its being the primary obstructing factor. The cases with accessory lower polar vessels seem properly to be divided into four groups

(a) First are those congenitally obstructive from infancy, such as the case recently reported by Verliac, and also in one of our series. Our case was a lad of eighteen years, who had no recollection of ever being free of a constant left loin ache. It was present from earliest childhood and verified by his parents. Nausea and vomiting were the only clinical symptoms, and there were no urinary symptoms and no urinary infection.

(b) Secondly are those cases where the obstruction from accessory vessels develops only as growth and puberty change the dynamics of the urinary excretion. We had two such cases, and both again were males. Of the nine cases we have reason to believe that symptoms probably dated from early adolescence in five of them. Both of the above types are prone to have incomplete ascent of the kidney, or incomplete rotation, and it is easy at operation to demonstrate the pathogenesis. The silence of these lesions for any active urological symptoms, or signs, accounts for the ordinary delay in their recognition. Gastro-intestinal disturbances are the rule and absorb the practitioner's attention. Yet in their early stages these cases represent in its purest form the *potentially dysuric kidney*, whose early surgical rectification is essentially demanded if the organ is to be saved. If left alone, they constitute the most ideal soil preparation for infection or stone formation, which at once introduces a complication much to be feared.

(c) In the third group the existence of an anomalous vessel has been of no importance until a secondary factor, such as trauma, ptosis or the pelvic distention associated with pregnancy, brings its obstructive powers into play, from which time anomalous vessel, obstruction and hydronephrosis become interacting, self-perpetuating and increasing. This is probably the most usual type in surgical experience.

(d) The fourth group includes those in which, though aberrant vessels are present, they play no part in the obstructive nephropathy.

It is of especial interest that in these nine cases, where anomalous vessels were adjudged the cause of the obstruction, in only one of them was the kidney a true third-degree dystopia, and in only two others was a second-degree dystopia found. Yet of these nine cases seven presented large hydronephroses, one a moderate hydronephrosis in a pancake kidney and one slight hydronephrosis with pain and hæmaturia. In the entire study of forty-six cases, in forty-two of whom hydronephrosis was present, there were eleven in whom no actual ptosis occurred, and six of these were cases of aberrant vessels. This is rather strong evidence of the part played by such anomalies and is a diagnostic point in certain cases in explaining pre-operatively the reason for hydronephrosis in the absence of demonstrable ptosis. There appears to be necessary in these cases but a very slight change in renal position for the aberrant vessel to begin to cause obstruction. Of the nine cases with aberrant vessels two were infected, one practically destroyed kidney was removed, the other has been temporarily saved, the remaining

sterile cases (seven) were treated by severance of the anomalous vessel and nephropexy

Ptosis—Renal ptosis was present in all but eleven of the forty-six patients, but in twenty-two of the series it was judged the sole cause of the obstruction. The relationship between such renal dystopia and obstructive nephropathy is well recognized, though a constant reminder must be observed of the frequency of this condition in the absence of symptoms. The oft-quoted figures of Dr Hector MacKenzie that, of every 100 women, twenty will have ptotic kidneys, but only four will have symptoms therefrom, have been frequently corroborated. During the past four years, since we have been able to study the entire dynamics of the urinary tract by intravenous urography and thusly visualize the same in varying intervals of time and changes of position, undisturbed by the artifacts of cystoscopic instrumentation, it has been intensely interesting to observe the great number of patients with very evident renal ptosis but in whom acceptable evidences of obstruction have been absent.

Similarly of interest have been those cases of bilateral ptosis and unilateral symptomatology, and these are some of the facts that again bring home the realization of the necessity of further anomalies in order that such dystopias become symptom-producing. From studying these cases, I am convinced that the relationship between ptosis, pain and hydronephrosis is purely individualistic, for symptoms are often long existent before hydronephrotic dilatation is demonstrable. This may be due to the fact that one person lies down and gains relief sooner in each attack than another person, and hence the reiterated renal insult is lessened, though symptoms continue recurrently. Another point recently brought out by Rose is the difference in subjective symptoms, according to whether the hydronephrotic pelvis is intra- or extrarenal, and it is expected that the intrarenal pelvis produces pain in excess of the hydronephrosis, while the extrarenal pelvis is frequently to be found of astonishing size but presenting minimal symptoms.

There were twenty-two cases of simple renal dystopia, one palpable, nine movable and twelve floating, if we adopt Kelly's classification. Each presented acceptable evidence that the dystopia alone was responsible for the hydronephrosis and the symptoms therefrom. In only one of these cases was a chronic infection present, as likewise a soft renal calculus, which latter was undoubtedly secondary to the stasis and infection, and its removal, when drainage was established, was but a step in the proper handling of the surgical problem. This patient (a male) has gained forty pounds in weight and is working, but there has been a disappointing return of his renal function, and stasis has not been entirely relieved. One other case with third-degree dystopia was associated with a large pelvic neoplasm, and as both lesions were diagnosed pre-operatively, nephrectomy was performed. The remaining twenty cases presented eleven third-degree dystopias

and nine of second-degree dystopia. In each of these the dystopia alone appeared to be the cause of the symptomatology. Each was free of infection, and the results of nephrolysis, ureterolysis and nephropexy have been especially satisfactory in this group, for we have sixteen cures to report in this group of twenty patients.

Peri-ureteritis—The third most prominent cause of the obstruction in this series was peri-ureteral and peripelvic adhesions, and in thirteen cases it was considered to be the factor responsible. This is a most interesting group as it is not necessary to have a true urinary infection present. In fact, five of these cases were devoid of infection at their pre-operative study. Yet at operation one finds dense connective-tissue changes, associated with fixation, angulation, kinking or immobility of the ureter. This leaves little doubt but that this lesion must be associated with some form of low-grade chronic infection of a purely local character. Twice we have seen this associated with a retrocecal appendicitis and in one instance so diagnosed the condition pre-operatively. Today we believe one is justified, in all such cases, in performing an intraperitoneal exploration of the appendix as a step in the operation, which of course should be done before the urinary tract has been actually opened.

In five of these cases the upper ureter, the ureteropelvic junction and the hydronephrotic pelvis were found so densely encased that, to perform a satisfactory ureterolysis, these structures had to be stripped out, or circumcized from their embrace before normal relations were again established. The possibility that these dense fascial sheaths may represent vestigial remains of prerenal organs and are hence of congenital origin is an interesting thought to dwell upon as to their etiology.

Varying lesser degrees of inflammatory peri-ureteritis were responsible in eight patients, and observations were made on some of these where angulations by almost insignificant bands were freed to immediately observe active peristaltic waves pass successively down and rapidly empty the distended pelvis. In only two patients was nephrectomy necessary, in both of whom massive pyonephrosis existed.

Submucous Fibrosis—The remaining two cases have been classified as true ureteral stricture, and in each case it was situated at the ureteropelvic junction. One was without infection, with only a first-degree ptosis, but a large hydronephrosis, while the other was infected, with a second-degree ptosis and a large hydronephrosis. The former was handled by a ureteropelvic pyeloplasty, in addition to the ureterolysis, nephrolysis and nephropexy, the infected case had to be nephrectomized as the condition was of eight years' standing.

Symptomatology—Of outstanding importance in the clinical interpretation of these cases is the appreciation of the fact that true urinary symptoms are often conspicuous by their absence. Where infection is not present, neither symptoms nor signs attract the patient's attention to the urinary

apparatus, and hence the physician is misled from the very outset. The frequently repeated story is that, after a varying period of months and years, of fruitless therapeutic endeavor, a transitory hæmaturia was the first symptom that focused attention on the true location of trouble. Hæmaturia was recorded as a symptom at the time of the first urological consultation in one-third of our patients. Nausea and vomiting were outstanding symptoms in sixteen patients, some of whom had cultivated the habit of willful vomiting in order to gain relief after eating. Ten were markedly constipated. Fifteen of these forty-six cases had had a previous abdominal operation, and nine of them had had more than one such. In this series thirteen patients referred all their symptoms to the gastro-intestinal tract. In twenty-two patients a dull ache in the loin or lower right or left quadrant was present and drew attention to the possible renal or ureteral condition. Fifteen had suffered true renal colic, and seven were to varying degrees dependent upon morphia. Dysuria in fourteen and urinary frequency in twelve of them comprise the only outstanding urinary evidence. Vague backache was complained of by fifteen, pain in the iliac regions by twelve, while nine had themselves noticed an abdominal mass. An increase in all symptoms at time of menstruation is another misleading but frequent observation.

As symptoms of complaint, one must interpret the story of unilateral dragging, discomfort, gastric distress that passes through all the phases of indigestion to active attacks of nausea and vomiting, but one should look with discredit on any one who is not rather promptly improved or relieved by recumbency. One naturally becomes wary of the confirmed neurasthenic with multiple abdominal scars, who enjoys being the family invalid. Our present-day methods of investigation, when properly handled and intelligently interpreted and analyzed, should rarely allow such a one to slip through to another operative procedure, though I fear we have all been fooled a time or two in the past.

Diagnosis—It seems beyond a doubt that a keener appreciation of urographical study, an accumulating knowledge of roentgenographical interpretation, and a better understanding of the dynamics of the excretion of urine are responsible for a rebirth of interest in this subject. With the advent of the modern intravenous method of urography came a positive means of determining faulty function and a secondary means of studying post-operative results. Intravenous urography, now four years old, has carried this field of diagnosis, good as it was before, marvelously farther towards perfection. Today, without the disturbing influences of instrumentation, we are able to picture the complete physiological functioning of the excretory urinary channels. The dynamics are pictured with time and opportunity to vary position or focus, to check or double check any uncertain aspects, and later to gain post-operative knowledge of results without subjecting a patient to cystoscopy. Cystoscopical pyelography is neverthe-

less a court of arbitration, and in this series it was utilized wherever it seemed indicated

The method of intravenous urography is so simple, so valuable and so harmless that we wish to urge that it be included in the routine study of every abdominal case where the time element can be safely spared. Accurate and proper interpretation of the plates so obtained is of course an absolute essential, but a pit-fall into which it is easy to make a misstep

Today the diagnosis of every case of obstructive nephropathy is obtained from these evidences *with but one exception*. This one exception we consider of the foremost importance, and it is the ability to reproduce the symptoms of complaint on artificial distentions of the renal pelvis that is under suspicion. Such is not to be elicited by a careless leading question that any neurasthenic would bite on, but the accuracy with which a true case can be made to experience a typical attack—be the symptoms what or where they may—is a diagnostic asset of the very utmost value.

Another point of interest was the small number (twelve, or 26 per cent) that presented the classical picture of a long, thin body with flat chest and narrow subcostal angle. The patient with poor abdominal musculature was also in the minority. So these two features, so often quoted to make one suspicious of acquired renal dystopia, though unquestionably related, are by no means a necessity. Only once have we obtained that other classical diagnostic point of sudden bladder filling at periodic intervals or with change of posture. The average age in this series is thirty-four and a half years, the oldest sixty-one years and the youngest seventeen years.

One thing further should be emphasized. To date we are unfortunately seeing extremely late manifestations of the conditions portrayed. The effort should be made, in every branch of surgery, to permit corrective operative procedures early. It is truly remarkable to observe the rapidity with which the renal pelvis attempts to return to normal when once satisfactory drainage is established. We should not have to wait (as unfortunately has been advised by some), until gross evidence of hydronephrosis is present to diagnose and advise corrective treatment. We should be prepared to recognize the condition without waiting for the development of pathological results. It is essential that the potential dysuric kidney be early recognized and corrected, rather than ask for the uncertain return of a third-degree hydronephrosis.

Results—In nine patients nephrectomy was necessary. One had a complicating pyelitic tumor. One was a congenital condition and the kidney functionless. Five had suffered from six months to eight years, were chronically infected, with marked renal destruction, and the outlook was not worthy of a trial to save the organ. Another had an acute infection of a congenital hydronephrosis. In the last case an economic pressure demanded as prompt a return to health as was surgically possible, and we bowed to such necessity where again the outlook was none too promising.

In three others secondary nephrectomy is threatened. In one a ureter

was severed and reimplanted in order to save an aberrant inferior polar vessel. Symptom-free, he nevertheless has had a poor result on follow-up functional and urographical studies. The second is a woman whose home life is wretchedly unhappy and unquestionably arduous. Possibly she returned to work and trouble too soon, but she has still a continuation of painful symptoms and has not been able to allow us a follow-up study. The third, infected and with a soft stone, was an early case, and today I would say that we did not do enough and did not drain properly.

The remaining thirty-four where nephrolysis, ureterolysis and nephropexy were performed, we can classify as twenty-six complete recoveries, three with partial recovery and five awaiting our six-months' period of post-operative follow-up examination. In two cases with good recovery the solitary remaining kidney was the seat of the operation, its mate having been removed in earlier years. Of the nine cases of aberrant polar vessels eight were severed in order to obtain a complete ureterolysis. There have been no ill effects in either immediate or late post-operative recovery in them.

There were eleven cases of badly infected pelves. Five were nephrectomized and six subjected to ureterolysis, nephrolysis and nephropexy, with added temporary pelvic drainage, with five good results and one poor, and this latter the one referred to above of ureteroneostomy. There has been one late post-operative death, due to chronic interstitial nephritis, substantiated at autopsy study.

Treatment—The operation that we have used has always been varied to meet the individual problems but with basic steps required in all.

The ureter is generally first exposed and carefully studied as it approaches its kidney in an effort to trace upward from normal ureter to the point of possible blockage. This area, if found, is carefully dissected to determine cause and effect and outline a mode of corrective surgery. Polar vessels are ordinarily sacrificed, adhesions are completely removed, and in the cases of stricture at the ureteropelvic junction a pyeloplasty of generous dimensions has given us our best results.

The kidney is then completely exposed and thoroughly cleaned of all adherent perirenal fat and fascia. The step is carried to include pelvis and pedicle vessels, so that in the end your completely cleaned kidney, pelvis and ureter are free of all encumbrances, but this must be accomplished by delicacy of handling and never by undue roughness.

If infection is present, the pelvis is buttonholed and a curved lithotomy forcep passed into the inferior calyx and out through the cortex on the renal periphery and, by its aid, a catheter drainage tube pulled into the pelvis. The step is almost bloodless, and one can choose the point for perforation where the cortex is especially thin and drainage will be best accomplished. The tube is ordinarily large enough to put the walls of the punctured tract on tension, and hence the lack of either bleeding or the necessity for any stitching.

The upper posterior face of the kidney is then decapsulated and the capsule folded downward, so that the two fixation stitches then placed on the posterior face of the lower pole have the added strength of this capsular tissue in preventing their cutting out

The renal fossa is next prepared by stripping all fat and fascia from its posterior wall, shoving the same medianward

Next the kidney is fitted to its new (or old) bed, and the traction stitches are so placed in relation to lower ribs, the arcuate ligament, or quadratus muscle as to allow a free play to the ureter and a little tilting outward of the lower pole. Ordinarily two-thirds of the kidney are placed above the edge of the lowest rib when fixation is finished and sutures tied. The table is then flattened, the work and the ureter again inspected, and closure made in layers, with or without drainage as indicated

The patient is nursed on her back for two weeks, during which time the foot of the bed is elevated ten inches, and a third week in bed is varied by moderate turning but with competent abdominal support

In summary let us accentuate the following points

- (1) The urological examination of all non-acute abdominal cases, *etc.* an intravenous urographical study
- (2) Investigation of the appendix where peri-ureteritis is present
- (3) Drainage in infected cases by nephrostomy in addition to nephropexy and ureterolysis
- (4) The realization that one should not have to await the development of hydronephrosis before being able to diagnose its incipency and recognize the potentially dysuric kidney
- (5) Corrective surgery must be, perforce, early surgery

PRIMARY TUMORS OF THE URETER WITH SPECIAL REFERENCE TO THE MALIGNANT TUMORS

REPORT OF THREE CASES

BY JOSEPH A. LAZARUS, M.D.

OF NEW YORK, N. Y.

PRIMARY tumors of the ureter fall into two main groups, namely epithelial tumors and non-epithelial neoplasms, or those arising from structures other than the mucous membrane of the ureteral wall. The epithelial tumors may be subdivided into the papillomata, the papillary carcinomata and the non-papillary carcinomata. This report will deal chiefly with the carcinomatous tumors of the ureteral wall.

Papilloma—The benign papilloma may occur singly or in groups which at times may fill the entire ureteral lumen. It is strictly a mucous membrane growth made up of villæ, each one of which has a core consisting of fibrous tissue which contains a small vessel, the entire core being surrounded by a layer of columnar epithelium (papillary-fibro-epithelioma). It is in all respects identical with the bladder papilloma. Although the consensus of opinion is that papillomata are true tumors, Stoerk¹ maintains that the papilloma represents the product of a chronic inflammation, a true hyperplasia, resulting from mucous membrane irritation similar to that which occurs in the larynx, gall-bladder or intestine.

Papillary Carcinoma—Although these tumors outwardly resemble the benign papillomata, and do, in fact, frequently arise from them, a careful study shows that the individual papilla of the malignant tumor is thick and club-like, and in addition the tumor is attached to the ureteral wall by a broad pedicle. While the benign papilloma displays a great tendency to occur multiply, the malignant tumor usually remains single. The microscopical criteria of malignant cells with their tendency to invade the stalk are features which are sufficient to differentiate the malignant from the benign tumor. The papillary carcinoma shows a definite tendency to metastasize and invade adjacent structures. Metastases to regional and retroperitoneal lymph-nodes have occurred in 48.1 per cent of the series here to be reported, while metastases to distant organs such as the liver and the lung (22.2 per cent and 18.5 per cent, respectively) are not uncommon. The tumors are usually situated in the lower or pelvic portion of the ureter and as a result of their tendency to occlude the ureteral lumen are frequently associated with hydronephrosis and hydro-ureter.

Non-papillary Carcinoma—The non-papillary group of carcinomata represented by adeno-carcinoma, carcinoma-solidum, medullary-carcinoma, encephaloid-carcinoma, scirrhous- and squamous-cell carcinomata, constitute about 42 per cent of all the malignant growths of the ureter. A few cases

have been reported where the tumors were mixed, as in the case of Adler² where there was a combination of squamous and papillary carcinoma, and the case of VorPahl³ where the tumor at the ureteral orifice consisted of medullary carcinoma and that found in the mid-portion of the ureter of scirrhus carcinoma. The squamous-cell tumors are frequently associated with calculi or with other types of inflammatory lesions. Aschner's⁴ case, for example, was associated with leucoplakia of the surrounding ureteral mucosa. Similar association between cancer and calculus is seen in the gall-bladder. Judd and Struthers⁵ maintain that this combination is present in 16 per cent of all cases, while Kretschmer⁶ found only five cases associated with calculus. Our studies indicated only ten instances of ureteral calculi in a collected series of sixty-eight cases of carcinoma of the ureter, including three cases of the author, an incidence of 14.7 per cent. The literature indicates two cases associated with anomalies of the ureter, one by Neelson,⁷ in which there was a forking of the ureter with a double pelvis, and the other by Jona,⁸ in which the tumor occurred in a sort of diverticulum of the ureter. In one of the cases (Case 1) reported by the author, there was a double ureter.

Incidence—Primary carcinoma of the ureter was first reported by Rayer,⁹ in 1841. It was not until forty-three years later that the first report of such a tumor appeared in English by R. Davy.¹⁰

Women are affected almost as frequently as men (32/36). The greatest incidence of carcinoma of the ureter occurs in the sixth and seventh decades. Out of sixty-eight cases, fifty-one occurred between fifty and eighty years of age. The oldest patient was a female, eighty-nine years of age, reported by Toupet and Gueniot,¹¹ and the youngest thirty-five (one case by Finsterer¹² and the other by Hofmann¹³). About half of the reported cases occurred in the lower part of the ureter. The right ureter was affected almost as often as the left (32/33), three reporters failing to mention the side involved.

Symptomatology—There are no symptoms sufficiently characteristic to differentiate a benign from a malignant growth of the ureter. In fact, it is almost impossible from symptoms alone to ascertain whether the lesion is in the ureter or in the corresponding kidney. Pain, hæmaturia and tumor constitute the triad of symptoms suggestive of this disease. And yet, all three of these symptoms are not always present in any given case. Hæmaturia is by far the outstanding, and often the earliest, symptom of malignant tumor of the ureter, being present in 75 per cent of the cases collected in this series. In fact, it may be the only symptom as in the cases of Albarran,¹⁵ Suter¹⁴ and others. On the other hand, hæmaturia may be entirely absent (Wising and Blix,¹⁶ Toupet and Gueniot,¹¹ and others). The hæmaturia is usually profuse, intermittent and unaccompanied by pain, although colic may occur as a result of the passage of clots through the ureter. It is not at all infrequent to recover small worm-like clots from the urine passed in such cases (Jona⁸). Hæmaturia of ureteral origin does not differ from that seen when the source of the bleeding is in the kidney.

Meeker and McCarthy¹⁷ have shown in their case that pain may consti-

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tute the only symptom in carcinoma of the ureter. A careful study of our statistics referable to this symptom reveals the fact that 45.5 per cent of the patients complained of renal pain, 58 per cent complained of abdominal pain and 87 per cent gave backache as one of the symptoms. In cases where pain is not due to the passage of blood-clots it results from retention of urine due to the partial or complete occlusion of the ureteral lumen by the growth. Occasionally, the pain is attributable to the concomitant existence of a ureteral calculus (Metcalf and Safford,¹⁸ Paschkis,¹⁹ and others). There is another type of pain which is due to pressure or invasion of the tumor upon adjoining structures, in which event the pain usually radiates to the abdomen, pelvis or perineum. Sciatica was complained of by Israel's²⁰ patient as a result of the pressure by the tumor upon the sacral plexus.

In every type of ureteral tumor, benign or malignant, there occurs during some stage of its growth an obstruction to the flow of urine from the corresponding kidney which leads to retention of urine and to a dilatation of the ureter and renal pelvis, and eventually to hydronephrosis and hydro-ureter. It is the hydronephrotic kidney which is readily palpated in the flank and often designated as a tumor, as was recorded in 35.2 per cent of the collected cases in this series, although a survey of the pathological specimens recovered by operation or autopsy disclosed an incidence of hydronephrosis of 67.6 per cent indicating thereby that although this condition is present very frequently, it is noted in the course of physical examinations in only slightly more than half of the cases. In those cases where hydronephrosis was not present, it was due to the fact that the tumor either remained small or was situated at the ureteral orifice and showed a tendency to grow into the bladder rather than into the ureteral lumen as was noted in the cases reported by Finsterer, Chiari²¹ and Hofmann.¹³ In certain well-advanced cases (Butler,²² Paschkis and Pleschner⁵⁸ and others), it is at times possible to feel the actual ureter tumor through the abdominal wall, rectum or per vaginam, and in the case of the latter may be mistaken for adnexal neoplasm (Albarran,¹⁵ Israel²⁰).

Diagnosis—A survey of Table VI indicates that only twenty-two cases including three of the writer's an incidence of 32.3 per cent, were diagnosed as tumors of the ureter, and four additional cases as probable tumors of the ureter, leaving about 62 per cent of the cases where this lesion was not even suspected. It is also of interest to note that up to about 1915 most of the diagnoses were made at post-mortem. Gerstein,²³ in 1902, was the first to diagnose the condition clinically, and, in 1912, Chevassu and Mock²⁴ also made a clinical diagnosis of ureteral tumor. Chiari²¹ noted the possibility of such a lesion in 1914, while Neelson,⁷ one year later, made a correct pre-operative diagnosis. Since then, with the use of the more modern procedures in urological study, the incidence of correct pre-operative diagnosis becomes more marked. In other words, it is quite evident that it is exceedingly difficult to make the diagnosis from symptoms and physical signs alone. Given the three cardinal symptoms, namely hæmaturia, pain and tumor, one must

suspect calculus, inflammation or tumor. X-ray usually suffices to rule out stone. At times, finding of atypical cells in the centrifuged specimen of urine, or even of papillary-like tissue, may arouse suspicion of tumor as in the case of Krafft²⁶

It is upon cystoscopy and the various allied procedures associated with it that we must depend to make the diagnosis of ureteral tumors. Through the observation telescope blood may be seen coming through one ureteral orifice (17.3 per cent) or a papillary excrescence may present at a ureteral meatus (29.4 per cent). Blum²⁷ was the first to describe a case in which, during the ureteral systole, a papillary tumor appeared through the meatus only to disappear again during diastole. This same condition was found by Caporale²⁸. E. Wassidlo described a case in which a papillary tumor presenting at the ureteral orifice grew larger with the expulsion of urine from the ureteral meatus.

One of the most helpful diagnostic methods is the passage of the ureteral catheter. An obstruction is frequently encountered at the site of the tumor (38.2 per cent). This in itself is not of diagnostic importance, but the provocation of bleeding following the manipulation of the catheter at the site of the obstruction is definitely significant. Bee²⁹ commented upon the nature of the bleeding in such cases by stating that where the obstruction is due to a tumor the blood, instead of dropping out of the end of the catheter intermittently, drops out continuously. Krafft²⁶ suggested massaging of the ureter to evoke bleeding in cases of suspected ureteral neoplasms. This observation was confirmed by Gottlieb³⁰.

A filling defect in the ureterogram is of great diagnostic importance (Crance and Knickerbocker,³¹ D'Aunoy and Zoeller,³² Scheele,³³ author).

However, this procedure cannot always be carried out since in deep-seated and infiltrating tumors the fluid medium cannot be made to pass the obstruction, but flows back into the bladder without delineating the growth. Crance and Knickerbocker³¹ were the first to clearly demonstrate a tumor of the ureter by this method. Later Scheele,³³ Stewart³⁴ and others showed the lesion by using fluid medium. Neuwirth and Bedrna³⁵ showed the possibility of demonstrating ureteral tumors by pneumo-ureterography. Although a case may present hæmaturia and an enlarged kidney, and bleeding may be induced by the passage of a ureteral catheter and the Röntgen plate may fail to show the presence of a stone, yet the diagnosis of a ureteral tumor must remain problematic. It is only when the ureterogram demonstrates a filling defect that the diagnosis can be made with certainty. This procedure is of course not indicated in cases where a tumor is actually seen presenting at the ureteral orifice. Owing to the difficulty of establishing a correct diagnosis, several cases have been operated upon for hydronephrosis in which, following the extirpation of the kidney, a second operation had to be performed to remove the tumor-bearing ureter (Van Capellen,³⁶ Judd and Struthers,⁵ Sutter, Toupet and Gueniot, and others). Even at operation it may be impossible to feel a soft papillomatous type of tumor in the ureter. In 29.4 per cent

of the cases within this series, the diagnosis was established by the presence of a tumor protruding from the ureteral meatus

Metastases—Metastasis and invasion of neighboring structures are characteristic of malignant tumors of the ureter. A survey of Table V indicates that the retroperitoneal nodes (48.1 per cent), liver (22.2 per cent), kidney (18.5 per cent) and lungs (18.5 per cent) constitute the most frequent sites for metastatic deposits. Invasion by the tumor into the neighboring muscles such as the psoas occurred in 11.1 per cent of the cases that came to autopsy.

Treatment—Although a review of the literature indicates a variety of treatments for this disease, the procedure of choice is complete nephroureterectomy by the extraperitoneal route. The transperitoneal method was used by Quimby³⁷ and by Paschalis and Pleschner.³⁸ The extirpation of a single tumor situated in the lower ureter was carried out by Finsterer through the suprapubic route, and also by J. Thomson Walker,³⁸ who resected the lower portion of the ureter harboring the growth, and reimplanted its proximal end back into the bladder. The procedure which the author employed in two of his cases was a complete nephroureterectomy through a long Albanian incision extended downwards toward Poupart's ligament, the resection including a portion of the bladder wall adjacent to the ureteral meatus. The defect in the bladder was closed in layers and an indwelling DePezzar catheter introduced into the bladder through the urethra and left in place for one week to ten days for the purpose of preventing urinary leakage through the vesical suture line. In the third case a complete nephroureterectomy was performed without including the ureteral meatus. The tumor which presented at the orifice was treated by fulguration and radium through a subsequent suprapubic systotomy after operation. It is advisable to follow the surgical procedure with a full course of deep Rontgen therapy, especially directed to the liver, lungs and spine.

Tumors Arising from Structures Other than Mucous Membrane—The tumors belonging to this group are of rare occurrence. They may arise from the musculature or connective-tissue constituents of the ureteral wall, are more frequently encountered in the young, and are rapidly growing malignant tumors. Unlike the epithelial type of tumor, they are rarely accompanied by hæmaturia. Watjen³⁹ reported a case of fibromyoma with hyalinization of the connective tissue and calcification which caused a stenosis of the lumen of the ureter, and suggested its origin from the smooth muscle of the wall of the ureter. Similar cases were reported by Brongersma⁴⁰ and by Djeng-Jan-Ku (quoted by Weinstock).⁴¹ A case of round-cell sarcoma of the ureter was reported by Target (quoted by Heller).⁴² Albanian quotes Witlutsky⁴³ as having found an alveolar sarcoma of the ureter and Voipahl attributes a similar case to Lichtheim.⁴⁴ Ribbert⁴⁵ reported a case of myosarcoma, and Binder⁴⁶ accidentally found at autopsy a tumor in the lower left ureter in a sixty-eight-year-old woman consisting of epithelium, muscle and connective tissue which had caused a stenosis of the lumen of the ureter. Caulk⁴⁷ re-

ported a hæmangioma of the juxtavesical portion of the ureter which could be felt through the vagina and which gave rise to hæmaturia

PERSONAL CASE REPORTS

CASE I—Mrs C W, aged forty-two years, first seen October 24, 1929, complaining of frequency of urination, dysuria and hæmaturia of three years' duration. On several occasions she experienced a dull ache in the left lumbar region. Although her appetite



FIG 1—(Case I) Pyeloureterogram showing defect in ureterogram and pyonephrosis. The quality of the image was poor, there was no apparent loss of weight. Past and personal history was essentially negative.

Cystoscopy—Cystoscopy revealed a bladder diffusely inflamed. Situated about one centimetre above the right ureteral orifice there was a circular necrotic area measuring about two centimetres in diameter, the lower part of which was covered with blood-clot while the upper part was of a pale yellowish color and distinctly villous in character. A pedicle could not be seen, nor was there any evidence of irritation around the base of the lesion. The right ureter was easily catheterized, while the catheter encountered an

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impassable obstruction in the left ureter three centimetres from the bladder. The 'pthalein concentration was good from the right kidney, and the urine obtained from that side showed a few red blood-cells. No specimen was obtained from the left kidney. Cultures



FIG 2—(Case I) Showing condition of kidney and ureter found at operation

from the right kidney were sterile and *B. coli communis* was recovered from the bladder. Specimens were negative for the bacillus of tuberculosis. Four days later a catheter was passed beyond the obstruction and reached to a point fifteen centimetres from the bladder.

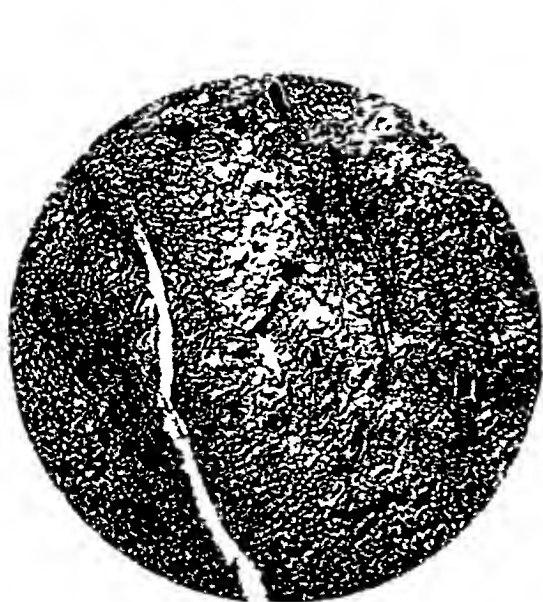


FIG 3—(Case I) Low power microphotograph of ureteral tumor



FIG 4—(Case I) High power microphotograph of ureteral tumor

where a second obstruction was encountered. A small quantity of thick turbid urine was obtained and showed pus microscopically. There was no return of the dye from

the left kidney. On culture, the specimen showed *B coli communis* and *Streptococcus hemolyticus*, but no evidence of tubercle bacilli.

A left pyelo-ureterogram revealed an enormous pyonephrosis with a marked dilatation of the upper ureter. In the region of the pelvis, and extending between the second and third transverse processes, there was a triangular negative shadow (Fig 1). A second negative shadow was seen in the ureterogram between the transverse process of the fifth lumbar vertebra and the base of the sacrum.

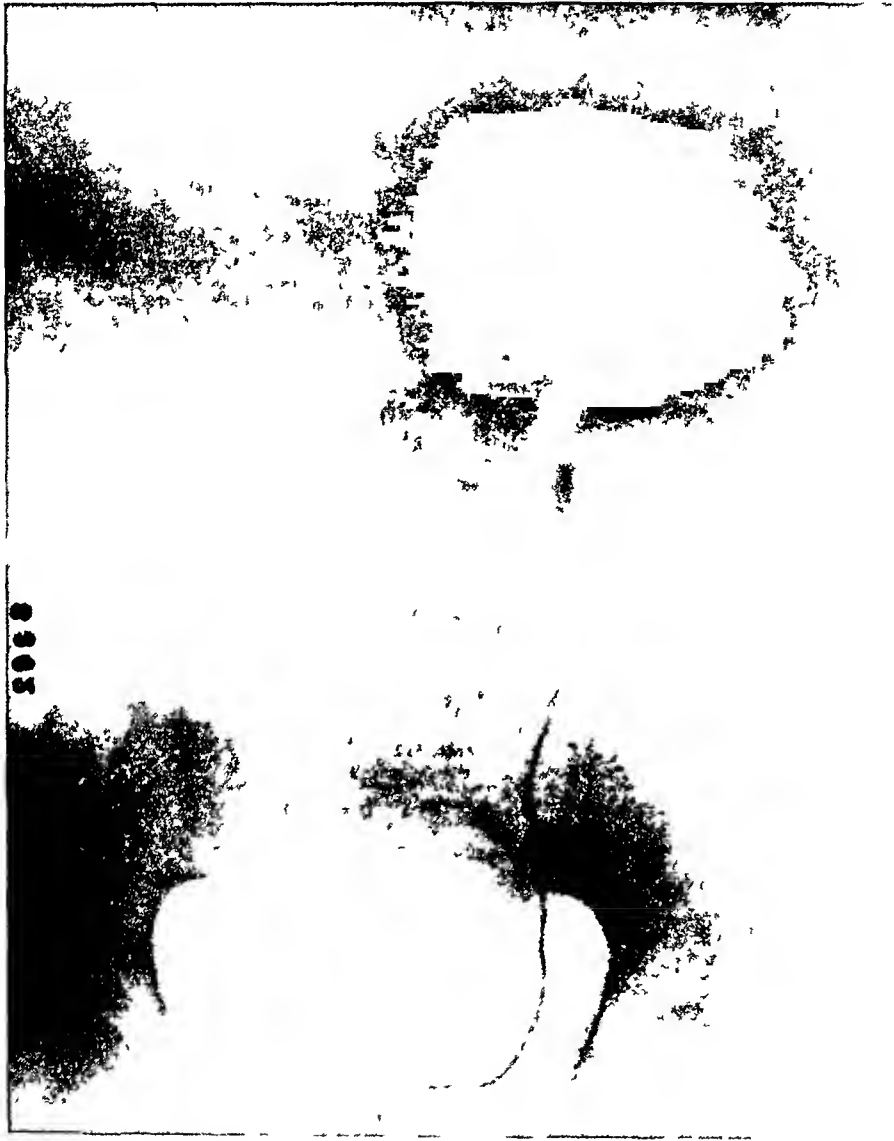


FIG 5 —(Case II) Left pyelogram showing pyonephrotic kidney. Only upper portion of the ureter is outlined.

Tentative Diagnosis—Left pyonephrosis, left pyo-ureter, left renal calculus and tumor of the left ureter.

Operation—October 31, 1929. Under spinal anesthesia (tropo-cocaine) supplemented with gas-oxygen narcosis, a complete left nephro-ureterectomy was performed. The kidney was completely pyonephrotic and contained a large calculus in its pelvis. Two ureters passed from the kidney to the bladder, one of normal size, and the other the size of a loop of small intestine. There was a high-grade periureteritis. In the juxtavesical

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portion of the dilated ureter there was an indurated mass about the size of a cherry which was definitely infiltrating into the surrounding structures

The kidney was mobilized through a seven-inch Albarran incision in typical manner and the ureters freed as far down as possible, and tied off with tape. The wound was then closed, the patient turned over on her back, and the ureters exposed extraperitoneally through a second incision and traced down to the bladder where they were divided between chromic ligatures. This wound was drained and closed in layers. The patient was then again placed in kidney position, the original wound reopened and the kidney with its ureters removed, after which the wound was closed in layers over appropriate drainage.

Pathological Report—Specimen consists of a kidney and two ureters, one ureter enlarged and thickened and the other of normal dimensions. Several large cavitations are seen within the kidney, each containing a calculus. Practically all of the renal parenchyma between the cavities is replaced by fatty and fibrous tissue. The renal cortex is about 0.2



FIG 6

FIG 6—(Case II) Showing condition of kidney and ureter after fixation in formalin. Note necrotic condition of ureteral wall and tumor at lower end.



FIG 7

FIG 7—(Case II) Note complete destruction of renal parenchyma.

centimetre in thickness. At the lower end of the dilated ureter there is a hard mass about the size of a cherry occluding the ureter lumen. (Fig 2)

Microscopic Diagnosis—Calculus-pyonephrosis of kidney, pyo-ureter, medullary carcinoma of ureter. (Figs 3 and 4)

Subsequent Course—November 30, 1929, the bladder was opened through the suprapubic route and five platinum-covered radon seeds aggregating 1,506 millicurie hours were implanted around the tumor over the left ureter orifice. The patient was discharged from the hospital December 19, 1929, in good condition. Cystoscopy performed two weeks later showed a slough at site of tumor.

Four months later cystoscopy revealed a tumor behind the right ureter orifice which was treated with radon seeds implanted through the cystoscope. The patient was recystoscoped five months later and no evidence of tumor found in the bladder. Deep Röntgen

therapy was given to the bladder, spine, lungs and liver When last seen in October, 1930, the patient had developed metastases to the spine

CASE II—C L, male, aged sixty-eight years, first seen May 15, 1930, complaining of hæmaturia of eight years' duration Save for a gonorrhœa forty years ago, and a chancre thirty-eight years ago, the past history was essentially negative The outstanding features of the physical examination were diffuse enlargement of the superficial lymph-nodes, dullness and increased breath sounds over both apices, feeble heart sounds and an enlarged, firm prostate

Cystoscopy—May 15, 1930 The bladder was thickened and trabeculated There was a moderate hypertrophy of both lateral lobes and a well-defined hypertrophy of the median lobe of the prostate Blood-clots were adherent to the left ureteral meatus Both kidneys were easily catheterized Urine from the right kidney was clear and negative



FIG 8—(Case II) Microphotograph of tumor

microscopically, while the urine from the left side contained blood 'Pthalein concentration right, good, left, poor Specimens from both kidneys were sterile on culture and negative for the bacillus of tuberculosis, while the bladder urine showed a growth of *Staphylococcus albus* Right pyelogram was negative Left pyelogram revealed a large pyonephrosis and pyo-ureter with an acute "S" kink in its upper portion A shadow suggestive of a stone could not be seen in the region of the kidneys or ureters The left renal silhouette was, however, larger than that of the right kidney (Fig 5)

The patient was again seen June 3, 1931, stating that he had had profuse hæmaturia for several days Cystoscopy revealed several blood-clots in the bladder, one being firmly adherent to the left ureteral orifice The lateral and median lobes of the prostate were greatly enlarged An attempt to catheterize the left ureter was unsuccessful due to the presence of an impassable obstruction at one centimetre from the bladder Uroselectan examination failed to show any dye in the left renal pelvis on a series of films taken over a period of two and a half hours Operation was advised and refused

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The patient was again seen May 16, 1932, complaining of profuse hæmaturia, fever and marked asthenia. Cystoscopy now showed a lenticular tumor about the size of a small pea attached to the upper lip of the left ureteral meatus. A catheter could not be made to pass into the left ureter. The left kidney was felt to be definitely enlarged. Uroselectan revealed a very large left kidney which did not concentrate at any time during the examination, its ureter was never outlined. The right pelvis and ureter



FIG 9—(Case III) Intravenous pyelogram. Note enormous enlargement of left kidney with complete absence of dye in pelvis or ureter.

were normal. A chest plate showed old healed tuberculous lesions in both lungs. There was no evidence of metastases. A diagnosis was now made of tumor of the left ureter, left pyonephrosis and pyo-ureter.

Operation—May 20, 1932. Under spinal anaesthesia (tropo-cocaine) a complete left nephro-ureterectomy was performed through a nine-inch Albarran incision. The kidney was enormously enlarged, reaching from the diaphragm to the crest of the ileum, completely pyonephrotic and intimately adherent to the surrounding structures. The ureter was markedly dilated and thickened and adherent to its bed. Situated in the extreme end

of the ureter there was a hard nodule about the size of a pea. The entire kidney, ureter and a portion of the bladder wall with the ureteral meatus were extirpated and the defect in the bladder closed with interrupted chromic sutures. The wound was drained and closed in layers. An indwelling catheter was passed into the bladder per urethram and strapped in place, the bladder being irrigated every six hours.

Convalescence was uneventful, the catheter was removed after ten days, and the patient was discharged from the hospital in good condition June 19, 1932, the twenty-ninth day after operation.

Pathological Report—Specimen consists of a kidney measuring eighteen by nine by eight centimetres, completely pyonephrotic, showing no parenchyma. The ureter measures eighteen by one and one-half centimetres with a tumor situated in its distal portion. The lumen of the ureter was filled with necrotic material. (Figs 6 and 7)



FIG 10—(Case III) Showing condition of kidney and dilated ureter. Note tumor at end of ureter.



FIG 11—(Case III) Ureter opened. Note two growths in lumen of ureter.

Microscopical Diagnosis—Diffuse pyonephrosis, pyo-ureter and papillary carcinoma of the ureter. (Fig 8)

CASE III—M B, a male, aged sixty-six years, first seen in consultation August 27, 1931, complaining of difficulty of urination and hæmaturia, at which time a two-stage prostatectomy was performed for a fibrosis of the prostate and contracture of the vesical neck. The patient was again seen six months later complaining of hæmaturia, loss of weight (ten pounds) and pains in both hips.

Cystoscopy—Cystoscopy revealed a moderately thickened and trabeculated bladder with well-defined Mercier's and median bars. The left ureteral orifice bulged into the vesical lumen and was surrounded by a small papillomatous tumor. The left catheter encountered an impassable obstruction at two centimetres from the bladder. The right ureter could not be visualized.

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Intravenous Pyelography—The pyelograms revealed the right kidney of normal size shape and position with a normally formed pelvis. The left kidney appeared enormously enlarged with a pear-shaped bulging of its lower pole. Plates taken at intervals over a period of four hours failed to show the presence of the dye in the left renal pelvis (Fig 9). Situated on the upper margin of the bladder silhouette and to the left of the mid-line, there was a shadow ovoid in shape and the size of a small cherry.

The outstanding features of the physical examination were a rough systolic murmur heard at the apex with an hypertrophy of the heart to the left, blood-pressure 200/100, the liver edge was palpable two fingers breadth below the costal arch and the left kidney felt greatly enlarged. There was a moderate ankylosis of the left hip. Rontgenological study of the chest failed to show the presence of pulmonary metastases. The pre-operative



FIG 12—(Case III) Microphotograph of tumor

diagnosis was left hydronephrosis, left hydroureter and primary carcinoma of the left ureter.

Operation—April 20, 1932. Under spinal anaesthesia (tropo-cocaine) the left kidney and ureter were exposed through a single nine-inch Albarran incision. The kidney was represented by an enormous sac involving mostly its pelvis and lower three-quarters of the renal parenchyma. The ureter was enlarged to the size of a loop of small intestine down to the bladder. At the juxta-vesical portion of the ureter one could feel a nodular mass about the size of a cherry. Situated at the ureteral orifice there was a papillomatous tumor, the size of a pea (Fig 10). The kidney and ureter were densely adherent to the surrounding structures (perinephritis and periureteritis). The renal pedicle seemed to enter the kidney very close to its upper pole.

With great difficulty the kidney and entire ureter were mobilized together. In order to remove a portion of the bladder adjacent to the left ureteral meatus it was necessary to divide the left vas deferens between two ligatures, the former procedure was then easily accomplished. The opening in the bladder was closed with interrupted chromic

sutures A rubber dam and tube were introduced into the pelvis, and one tube was placed into the renal fossa and the wound closed in layers, following which an indwelling catheter was left in the bladder per urethram

Specimen—The specimen consisted of a large hydronephrotic kidney measuring thirteen by eight by seven centimetres, filled with necrotic and hæmorrhagic fluid The ureter which was attached to the kidney measured seventeen centimetres and was over two and a half centimetres in diameter, and was filled with fluid similar to that found in the kidney Blocking the ureteral meatus there was a villous growth about the size of a small pea With the ureter opened, it was seen that there was a second growth about one and a half inches above the meatus which was flat, papillomatous, and occupying about one inch of the ureteral wall Situated about three-quarters of an inch above the growth just described, there was a third tumor which felt nodular and was the size of a lima-bean There was no growth within the kidney or its pelvis (Fig 11)

Microscopical Diagnosis—Left pyonephrosis, left pyo-ureter and multiple papillary adeno-carcinomata of the ureter (Fig 12)

Subsequent Course—The patient made an uneventful recovery, the wound healing by primary union with very little drainage through the tubes The indwelling catheter was removed on the ninth day after operation and the patient discharged from the hospital on the twelfth post-operative day Since leaving the hospital, he has been receiving a course of deep Rontgen therapy

TABLE I

68 cases	Females	32	Right	32	} 68
			Left	33	
	Males	36	Unrecorded	3	

Age Incidence	Number of Cases	Percentage
First decade	0	
Second decade	0	
Third decade	0	
Fourth decade	4	5.8
Fifth decade	17	25
Sixth decade	15	22
Seventh decade	19	27.9
Eighth decade	8	11.7
Ninth decade	2	2.9
Not recorded	3	4.4

TABLE II

Symptoms	Number of Cases	Percentage
Hæmaturia	51	75
Loss of weight	12	17.5
Renal pain	31	45.5
Pain in abdomen	4	5.8
History or evidence of calculus	10	14.7
Backache	6	8.7

TABLE III

Positive Diagnostic Signs	Number of Cases	Percentage
Enlarged kidney	25	35.2
Mass felt along course of ureter	7	10.2
Obstruction of ureter elicited with catheter	26	38.2
Blood through ureter catheter	12	17.5
Tumor presenting at ureter orifice	20	29.4
Filling defect in ureterogram	6	8.7

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TABLE IV

Duration of Symptoms	Number of Cases	Percentage
One month or less	5	9 8
One to six months	15	29 4
Six to 12 months	8	15 6
One to two years.	11	21 5
Over two years	12	23 5
Unknown or unrecorded	17	

In this table fifty-one patients are used as basis of estimation, since in seventeen the duration of symptoms is unrecorded

TABLE V

Pathological Reports

	Num- ber of Cases	Per- cent- age		Num- ber of Cases	Per- cent- age
Associated hydronephrosis	16	67 6	Metastases and direct invasions		
Associated hydro-ureter	35	51 4	(twenty-seven post-mortems)		
Reports of Microscopical ex- amination of ureteral tumors			1 Retroperitoneal nodes	13	48 1
1 Transitional cell	2	2 9	2 Intestine	1	3 7
2 Adeno-carcinoma	2	2 9	3 Peritoneum	1	3 7
3 Carcinoma solidum	3	4 4	4 Pancreas	1	3 7
4 Medullary carcinoma	6	8 7	5 Rectum	2	7 4
5 Carcinoma	6	8 7	6 Pericardium	1	3 7
6 Cylindrical-cell epithe- lioma	1	1 5	7 Bladder	5	18 5
7 Encephaloid carcinoma	1	1 5	8 Spleen	1	3 7
8 Scirrhus carcinoma	1	1 5	9 Liver	6	22 2
9 Papillary carcinoma	28	11 1	10 Kidney	5	18 5
10 Squamous carcinoma	8	11 7	11 Muscle	3	11 1
11 Epithelioma	9	13 2	12 Lung	5	18 5
12 Not recorded	4	5 8	13 Nerves	1	3 7
			14 Bone	2	7 4
			15 Vasa deferentia	1	3 7
			16 Vagina	1	3 7
			17 Prostate	1	3 7

TABLE VI

	Number of Cases	Percentage
Cases diagnosed as tumors of ureter	22	32 3
Cases diagnosed as probable tumors of ureter	4	5 8
Cases diagnosed as tumor of genito-urinary tract other than ureteral	13	19 1
Miscellaneous diagnoses	14	22
Cases in which no diagnoses were made	15	22 6

Summary and Conclusions—Primary malignant tumors of the ureter are exceedingly rare, as indicated by the fact that, after a careful search of the literature, only sixty-eight cases could be collected, including three reported by the writer in this communication. Of the total number of tumors, 42 per cent were of the non-papillary type. Malignant tumors of the ureter are most frequently found in the lower part of the ureter and are usually associated with hydronephrosis (67 per cent), and hydro-ureter (51 per cent.).

The disease is most prevalent in the sixth and seventh decades (50 per cent) The growth is invasive and metastasizes readily to the regional lymph-nodes (48 per cent), lungs (18 per cent) and liver (22 per cent)

Although pain, hæmaturia and enlargement of the kidney constitute the characteristic triad of symptoms of this disease, it was found that hæmaturia alone was the outstanding symptom (75 per cent) The diagnosis of this disease can be made, however, only by carefully executed and interpreted cystoscopical X-ray procedures The presence of a tumor at the ureteral orifice is a highly suggestive finding, yet it was reported in only 29 per cent of the cases in this series A definitely established filling-defect in the ureterogram is the only pathognomonic sign of a tumor of the ureter, and was reported in only 87 per cent of the cases The infrequency of this finding is probably due to failure to suspect the lesion and consequently to the failure of carrying out carefully made ureterograms If, upon encountering an obstruction in the ureter (38.2 per cent), provoking bleeding by manipulation of the catheter, and failing to demonstrate a shadow suggestive of calculus at the site of obstruction on the Röntgen film, one were to suspect the possibility of this condition, it seems to the author that repeated attempts at ureterograms would eventually demonstrate a filling defect in a greater percentage of cases, thus clinching the diagnosis of ureteral neoplasm Failure to diagnose such a lesion has on several occasions led the operator to perform a simple nephrectomy for hydronephrosis and to learn later to his great chagrin that the hæmaturia had recurred, thereby necessitating a second operation for the purpose of removing the tumor-bearing ureter Owing to the difficulty encountered at times of palpating the tumor within the ureter at the time of the operation, it seems better in those cases where operation is undertaken for the purpose of exploring the upper urological tract for hæmaturia especially when tumor of the ureter is not suspected, to carry out a complete ureterectomy with the nephrectomy in the event the kidney itself fails to fully account for the bleeding

The procedure of choice in the treatment of this disease is complete nephro-ureterectomy carried out by the extraperitoneal approach, the resection including a portion of the bladder adjacent to the ureteral meatus The operation is best carried out under spinal anaesthesia and concluded by placing an indwelling catheter into the bladder through the urethra and retained for a week or ten days

It is the hope of the writer that this analysis of reported cases of primary malignant tumors of the ureter may lead to a better understanding of this disease, so that future cases may be recognized earlier and the patients subjected to radical surgical procedures so essential to the attainment of successful results

ABSTRACT OF REPORTED CASES

P. Rayer (1841)—Female, aged fifty-eight years Clinical Findings—Pain in abdomen, hæmaturia Result—Autopsy Pathological Findings—Pedunculated tumors right ureter, calyces and bladder Microscopical—Not given

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Wising and Blix (1878) —Female, aged forty-one years Clinical Findings—Pain right flank and abdomen, enlarged right kidney Result—Autopsy Pathological Findings—Tumor upper right ureter, invading the renal pelvis with hydronephrosis, metastases to peritoneum, retroperitoneal nodes and rectum Microscopical—Medullary carcinoma

R Davy (1884) —Male, aged fifty-three years Clinical Findings—Pain left loin, penis, intermittent hæmaturia, enlarged left kidney Associated Calculi—Previous history of calculus left ureter Pre-operative Diagnosis—Cyst of left kidney and ureter Treatment—Nephrotomy and nephrectomy Result—Death two months after operation Pathological Findings—Kidney hydronephrosis, autopsy, hydro-ureter, tumor lower ureter with calculus, tumor invasion of bladder and perforation into rectum, metastases to liver and lymph-nodes Microscopical—Encephaloid carcinoma of left ureter

G Jona (1894) —Male Clinical Findings—History not given save of patient having a lobar pneumonia Pre-operative Diagnosis—Condition not suspected Diagnosis—Lobar pneumonia Result—Death Pathological Findings—Post-mortem Tumor left ureter probably occurring in diverticulum of ureter Microscopical—Epithelioma of ureter

F Voelscher⁴⁸ (1895) —Male, sixty-eight years old Clinical Findings—Backache, hæmaturia loss of weight Pre-operative Diagnosis—Malignancy, location not stated Treatment—Tapping of a fluctuant tumor, probably kidney, no operation Result—Death Pathological Findings—Autopsy Tumor situated in lower two inches of left ureter, metastases to liver, lungs, lymph-nodes, right hydro-ureter and nephrosis Microscopical—Villous carcinoma of left ureter

H Rundle,⁴⁹ Tr Path Soc, London, vol lvii, p 128 (1896) —Male, aged forty-six years Clinical Findings—Enlarging tumor right flank, hæmaturia, loss of weight Pre-operative Diagnosis—Malignancy suspected, location not stated Treatment—Tapping of a fluctuant tumor, probably kidney, no operation Result—Death Pathological Findings—Post-mortem Tumor lower three inches right ureter invading bladder wall and vasa deferentia with hydronephrosis and ureter Microscopical—Squamous-cell carcinoma of right ureter

L Hektoen⁵⁰ (1896) —Female, aged fifty years Clinical Findings—Pain right loin radiating to hip, a tumor mass apparently attached to right ilium felt in right lower quadrant Pre-operative Diagnosis—Osteosarcoma Result—Death Pathological Findings—Post-mortem Microscopical—Medullary carcinoma of right ureter

Toupet and Guenot, Bull Soc Anat de Paris, vol xii, p 677 (1898) —Female, aged eighty-nine years Clinical Findings—Pain in abdomen, loss of appetite, no hæmaturia, large tumor left side of abdomen Pre-operative Diagnosis—Hydatid cyst, hydronephrosis Result—Death Pathological Findings—Post-mortem Obstructing tumor left upper ureter (uretero-pelvic juncture), left hydronephrosis Microscopical—Carcinoma of left ureter

Toupet and Guenot, Bull Soc Anat de Paris, vol xii, p 677 (1898) —Female, aged sixty-four years Clinical Findings—Pain in right loin, hæmaturia, palpable mass right abdomen Cystoscopy—Obstruction right ureter at five centimetres Treatment—Nephrectomy, followed at a later date by ureterectomy Result—Recovery Pathological Findings—Surgical specimen Right hydronephrosis, hydro-ureter and tumor right ureter Microscopical—Solid carcinoma of the right ureter

B Poll,⁵¹ Beitr z Klin Chir, vol xiiii, p 822 (1899) —Male, aged forty-one years Clinical Findings—Pain left kidney, hæmaturia, history of injury to left hip and thigh, large left kidney Cystoscopy—Tumor present at left ureter orifice Pre-operative Diagnosis—Left renal tumor Treatment—Nephro-ureterectomy Result—Death thirty-one days post-operative Pathological Findings—Surgical specimen Left kidney, pelvis and ureter dilated and containing multiple papillary growths extending into the bladder Microscopical—Not given

K Minich⁵¹ (1902) —Female, aged sixty-six years No history Pre-operative Diagnosis —Not noted Pathological Findings —Post-mortem Tumor lower third of right ureter invading bladder and perforating vagina Microscopical —Carcinoma of right ureter

K Gerstein (1902) —Male, aged sixty-seven years Clinical Findings —Hæmaturia, urgency, pain right lumbar region, anæmia Cystoscopy —Tumor right ureter orifice Pre-operative Diagnosis —Malignant growth of right ureter orifice Treatment —Suprapubic cystotomy and fulguration of tumor Result —Died fifteen days post-operative Pathological Findings —Post-mortem Large tumor at right ureter orifice, two nodules right vesical wall, metastases to right kidney and lung, extension of tumor into prostate, right hydronephrosis Microscopical —Carcinoma right ureter

St Thomas Hosp Report,⁵² vol 1111, p 96 (1904) —Male, aged sixty-nine years Clinical Findings —Backache, hæmaturia, lump to the left of umbilicus Pre-operative Diagnosis —Not stated Treatment —Not stated Result —Death Pathological Findings —Post-mortem Left hydronephrosis and hydro-ureter with tumor of left ureter, metastases to retroperitoneal glands Microscopical —Cells of transitional epithelium

K Vor Pahl (1905) —Female, aged sixty years Clinical Findings —Intermittent right abdominal colic with large right kidney, urine showed red blood-cells Cystoscopy —Mass protruding from and obstructing right ureter orifice Pre-operative Diagnosis —Stricture or tumor of right ureter with calculus and hydronephrosis Treatment —Nephro-ureterectomy Result —Death eight hours post-operative (embolus) Pathological Findings —Post-mortem Right hydronephrosis and hydro-ureter with tumor of ureter, metastases to lungs, liver, retroperitoneal lymph-nodes Microscopical —Medullary carcinoma of right ureter orifice and scirrhous carcinoma of middle right ureter

W F Metcalf and H E Safford, *Am Jour Sci*, vol 1111, p 50 (1905) —Male, aged forty-seven years Clinical Findings —Attacks of right colic for years with history of stone passage on two occasions Physical Examination —Spasm left loin, otherwise negative Cystoscopy —Field obscured by bleeding Associated Calculi —Calculus Pre-operative Diagnosis —Left ureteral calculus Treatment —Nephro-ureterectomy Pathological Findings —Surgical specimen Left pyonephrosis and pyo-ureter with tumor and stone in lower left ureter Microscopical —Adeno-carcinoma of left ureter

L Adler (1905) —Male, aged sixty-nine years Clinical Findings —Intermittent pain over sacrum, radiating to bladder, tenderness left kidney, no hæmaturia Pre-operative Diagnosis —Tuberculosis, tumor of left adrenal (?), Addison's disease Result —Died Pathological Findings —Post-mortem Left hydronephrosis and hydro-ureter with tumor in lower left ureter, metastases to body of lumbar vertebra Microscopical —Papillary and squamous-cell carcinoma left ureter

Zironi⁵⁴ (1909) —Female, aged thirty-six years Clinical Findings —Pain in back radiating to bladder, hæmaturia, enlarged right kidney Pre-operative Diagnosis —Right renal tumor Treatment —Nephrotomy Result —Died Pathological Findings —Post-mortem Right hydronephrosis and hydro-ureter with tumor of middle third of right ureter, metastases to retroperitoneal glands Microscopical —Squamous-cell epithelioma of right ureter

J Richter⁵² (1909) —Female, aged eighty years Clinical Findings —Pain in sacrum and buttock radiating to right leg, hæmaturia Physical Examination —Negative Pre-operative Diagnosis —Neoplasm of urinary tract Result —Died Pathological Findings —Post-mortem Tumor, size of hazel nut, situated three centimetres above right ureter orifice, hydro-ureter and hydronephrosis, metastases to regional nodes Microscopical —Papillary carcinoma right ureter

R Paschke, *Wien Klin Wchnschr*, vol 1111, p 361 (1910) —Male, aged sixty-five years Clinical Findings —Recurrent left renal colic many years, severe attack four months ago with hæmaturia (hospital) Associated Calculi —Calculus Pre-operative Diagnosis —Malignant growth left renal pelvis with hydronephrosis Result —Died Pathological Findings —Post-mortem Invasive tumor size of a lemon in lower third

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of left ureter, metastases to left kidney and retroperitoneal nodes, hydronephrosis and hydro-ureter Microscopical—Papillary carcinoma left ureter

J Israel (1910)—Female, aged sixty years Clinical Findings—Pain left hypochondrium radiating to left breast, arm and thigh of ten years' duration, jaundice, hæmaturia, mass in abdomen (left) for ten years Pre-operative Diagnosis—Tumor left kidney with hydronephrosis Treatment—Splenectomy nephrectomy Result—Died after operation Pathological Findings—Post-mortem Tumor left ureter, metastases to left kidney, splenomegaly Microscopical—Papillary carcinoma left ureter

M Chevassu and J Mock, Bull et Mem Soc de Chir de Par, vol xxxviii, p 522 (1912)—Male, aged fifty-three years Clinical Findings—Pain in suprapubic region, scrotum, perineum one year, hæmaturia five weeks, double varicocoele Cystoscopy—Left catheter meets obstruction at fifteen centimetres with blood, poor function left kidney Pre-operative Diagnosis—Tumor left ureter Treatment—Nephro-ureterectomy Pathological Findings—Surgical specimen Left hydronephrosis and hydro-ureter, situated in the upper ureter there is a tumor about the size of an olive with a small nodule three centimetres below the first one Microscopical—Epithelioma left ureter

V Chiari (1914)—Female, aged fifty-four years Clinical Findings—Hæmaturia, loss of weight Physical Examination—Negative Cystoscopy—Left catheter meets impassable obstruction eight centimetres with return of blood, no function Pre-operative Diagnosis—Tumor of left kidney, left renal pelvis or left ureter Treatment—Nephro-ureterectomy Result—Recovery Pathological Findings—Surgical specimen A tumor situated in the middle of the left ureter extending into surrounding tissues, about the size of a cherry, with dilatation of the ureter Microscopical—Papillary carcinoma of left ureter

F A Butler, Clifton Med Bull, vol 11, p 48 (1914)—Male, aged fifty-three years Clinical Findings—Hæmaturia seventeen months, pain in right sacro-iliac region, loss of weight, situated to the right of the umbilicus a small fixed tumor was situated, attached to the posterior abdominal wall with enlarged right testicle Cystoscopy—Obstruction right ureter six centimetres from bladder Pre-operative Diagnosis—Sarcoma right ileum Treatment—Biopsy of tumor Result—Died Pathological Findings—Post-mortem Tumor situated in centre of ureter invaded the psoas and iliacus muscles, posterior peritoneum and lumbar plexus Microscopical—Squamous-cell carcinoma of right ureter

P Spiess,⁷⁵ Centralbl f allg Path u path Anat, vol xxvi, p 553 (1915)—Female, aged forty-one years Clinical Findings—Pain in loins, hips and hypogastrium Pre-operative Diagnosis—Sciatica, dementia præcox Result—Died Pathological Findings—Post-mortem Right hydro-ureter and hydronephrosis, tumor in lower right ureter with metastases in regional and mesenteric nodes and psoas muscle Microscopical—Carcinoma solidum simplex

H Finsterer (1915)—Male, aged thirty-five years Clinical Findings—Hæmaturia four years Pre-operative Diagnosis—Papilloma of bladder Treatment—Partial ureterectomy Result—Recovery Pathological Findings—Surgical specimen Right hydronephrosis and hydro-ureter with papillomatous tumor of left ureter Microscopical—Beginning malignant degeneration of papilloma of ureter

A Nilssen, Kristiania Kirurg forh, vol xiii (1915)—Female, aged sixty-eight years Clinical Findings—Hæmaturia two years, mass in right upper quadrant (kidney) Cystoscopy—Right ureter obstructed at fifteen centimetres, no bleeding, hydronephrosis tapped two years later, papillomatous tumor seen right ureter orifice Pre-operative Diagnosis—Malignancy of right ureter Treatment—Nephro-ureterectomy Result—Died one month after operation Pathological Findings—Right hydro-ureter with hæmatonephrosis, tumor right lower ureter Microscopical—Papillary carcinoma of right ureter with metastases to retroperitoneal nodes

K R Hofmann (1916)—Male, aged thirty-five years Clinical Findings—Hæmaturia four years, loss of weight Cystoscopy—Papillary tumor covering ureteral orifice

Treatment—Suprapubic cystotomy with resection of ten centimetres of ureter and implantation of upper end into bladder Pathological Findings—Surgical specimen Tumor of ureter the size of a pigeon's egg Microscopical—Papilloma with beginning malignant changes

Van Capellen (1916) —Female, aged forty-six years Clinical Findings—Pain right side, fever, frequency, hæmaturia, enlargement of right kidney with tenderness Cystoscopy—Redness of right ureter orifice, slow flow of cloudy urine from right kidney, no obstruction Pre-operative Diagnosis—Pyonephrosis Treatment—Nephrectomy and five months later ureterectomy Pathological Findings—Surgical specimen Right pyoureter and nephrosis with tumor in mid-portion of right ureter Microscopical—Papillary carcinoma of right ureter

E S Schmitt,⁵⁰ Jour Cancer Research, vol 1, p 461 (1916) —Female, aged fifty-five years Clinical Findings—Abdominal pain (diffuse) and in left inguinal region, vomiting and anemia, no hæmaturia Pre-operative Diagnosis—Intestinal obstruction, tuberculosis peritonitis Treatment—No operation recorded Result—Died twelve days after entering hospital Pathological Findings—Post-mortem Tumor situated in upper left ureter invading kidney, pelvis, psoas and vertebræ, with metastases to liver, left kidney and vertebrae, left pyonephrosis Microscopical—Transitional-cell carcinoma left ureter

Knack,⁵¹ Deutsch med Wchenschr, vol 44, p 982 (1918) —Male, aged seventy-three years Clinical Findings—No history given Pre-operative Diagnosis—No record, cardiac and renal insufficiency Result—Died Pathological Findings—Post-mortem Left hydronephrosis, right malignant sclerosis, mid-ureter tumor Microscopical—Papillary carcinoma left ureter

Paschke and Pleschner (1920) —Female, aged fifty-five years Clinical Findings—Pain in right kidney, hæmaturia, frequency, enlarged right kidney, a second small tumor felt below kidney Cystoscopy—Papillary tumor in region of right ureter orifice Pre-operative Diagnosis—Right renal tumor Treatment—Nephro-ureterectomy Pathological Findings—Surgical specimen Tumor of right ureter one centimetre above bladder, hydronephrosis and hydro-ureter Microscopical—Papillary carcinoma right ureter

Judd and Struthers (1921) —Male, aged forty-eight years Clinical Findings—Hæmaturia two years, pain in penis on micturition Cystoscopy—Blood left ureter, obstruction left ureter orifice by stone and tumor X-ray—Shadow lower left ureter Associated Calculi—Stone Pre-operative Diagnosis—Left ureter neoplasm, tumor left kidney, obstruction left meatus Treatment—Nephrectomy, eleven days later ureterectomy Result—Recovery Pathological Findings—Surgical specimen Left pyonephrosis and pyoureter, papillary tumor lower left ureter Microscopical—Papillary epithelioma left ureter

F Suter (1922) —Male, aged sixty-five years Clinical Findings—Pain in left kidney and hæmaturia Cystoscopy—Obstruction left ureter at eight centimetres from the bladder Treatment—Nephrectomy, secondary operation attempted, ureterectomy abandoned due to pressure of tumor against iliac vessels Pathological Findings—hydro-ureter, tumor mass over left iliac vessels

P W Aschner (1922) —Male, aged thirty-eight years Clinical Findings—Pain in right flank radiating down groin, vomiting, chills and fever, patient thought he passed stone, hæmaturia X-ray—Right renal calculi Cystoscopy—No obstruction to catheter Associated Calculi—Calculus Pre-operative Diagnosis—Renal calculi Treatment—Nephrotomy, secondary operation nephro-ureterectomy Pathological Findings—Surgical specimen Right hydronephrosis, tumor right ureter Microscopical—Squamous-cell carcinoma of ureter

Meeker and McCarthy (1923) —Male, aged forty-nine years Clinical Findings—Pain in right hip radiating to groin, cord-like structure felt in course of right ureter Cystoscopy—Right ureter obstructed at level of sacrum Pre-operative Diagnosis—

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Malignancy right ureter Result—Died Pathological Findings—Post-mortem Carcinoma right ureter, hydronephrosis metastases to liver lungs pericardium, spleen pancreas, left kidney and lymph-nodes Microscopical—Papillary epithelioma right ureter

H L Kretschmer (1924)—Male aged seventy-four years Clinical Findings—Hæmaturia, loss of weight Physical Examination—Negative Cystoscopy—Distorted left ureter no obstruction Pre-operative Diagnosis—Left renal tumor hydronephrosis Treatment—Nephro-ureterectomy Result—Recovery Pathological Findings—Surgical specimen Left hydronephrosis, tumor left ureter Microscopical—Papillary carcinoma of ureter

Crance and Knickerbocker (1924)—Female, aged forty-two years Clinical Findings—Enlarged right kidney hæmaturia, frequency dysuria pain in bladder X-ray—Negative Cystoscopy—Obstruction right ureter seven centimetres, no dye right kidney, ureteropyelogram, dilated ureter above obstruction, filling defect Pre-operative Diagnosis—Ureteral obstruction, probably tumor, hydro-ureter and hydronephrosis Treatment—Nephro-ureterectomy Result—Recovery Pathological Findings—Surgical specimen Right hydronephrosis and hydro-ureter, tumor right ureter Microscopical—Mucous-membrane epithelioma (carcinoma)

J Z Mraz⁹ (1924)—Female, aged sixty-nine years Clinical Findings—Pain in right lumbar region hæmaturia, loss of weight mass in left flank, small tumor palpable in region of right lower ureter Cystoscopy—Obstruction right ureter four centimetres, blood seen alongside catheter Pre-operative Diagnosis—Malignancy of upper urinary tract with secondary implantation in lower ureter and hydronephrosis Treatment—Nephro-ureterectomy Result—Died eight months after operation Pathological Findings—Surgical specimen Tumor right lower ureter right hydronephrosis Microscopical—Carcinoma of ureter

M Papin¹⁰ J d Vrol, vol xvii p 325 (1924)—Clinical Findings—Pain in right abdomen radiating to groin and right testicle, no hæmaturia but dysuria no masses loss of weight Cystoscopy—Obstruction right ureter three-quarters way up followed by bleeding Pre-operative Diagnosis—Probably neoplasm upper one-third right ureter Treatment—Resection of ureter containing tumor, kidney not removed Pathological Findings—Surgical specimen Tumor upper right ureter Microscopical—Cylindrical-cell epithelioma

Day, Fairchild and Martin¹¹ Surg, Gynec and Obst, vol xl, p 486 (1925)—Female, aged fifty-four years Clinical Findings—Hæmaturia, pain on right side, large right kidney Cystoscopy—Right ureter obstructed four centimetres Treatment—Nephrectomy and partial ureterectomy Result—Recovery Pathological Findings—Surgical specimen Right hydronephrosis, papillomatous tumor right ureter Microscopical—Papillary carcinoma right ureter

H V Zobel,¹² Centrabl f allg Pathol u path Anat, vol xxxvi, p 142 (1925)—Male, aged seventy years Clinical Findings—Not given Pathological Findings—Post-mortem Left perinephritic abscess with tumor size of a walnut in left ureter

H L Posner,¹³ Monatschr f Geburtsh u Gynaek, vol lxxv p 86 (1926)—Female aged sixty-six years Clinical Findings—Hæmaturia Cystoscopy—Tumor size of a cherry present at right ureter orifice Pre-operative Diagnosis—Stenosing carcinoma of right ureter with hydronephrosis Treatment—Cauterization of tumor, then nephrectomy and partial ureterectomy, later ureterectomy and resection of part of bladder Result—Recovery Pathological Findings—Surgical specimen Tumor filling two-thirds of right ureter right hydronephrosis and hydro-ureter Microscopical—Papillary carcinoma of right ureter

R L Stewart British Jour Surg vol xliii, p 667 (1926)—Female aged seventy-five years Clinical Findings—Intermittent pain right side, hæmaturia Cystoscopy—Bullous œdema right ureter orifice, obstruction Fifteen centimetres right ureter bloody urine obtained Pre-operative diagnosis—Tumor right ureter Treatment—Nephrectomy

and partial ureterectomy Pathological Findings—Surgical specimen Sessile papillary tumor right ureter, kidney and upper ureter normal Microscopical—Primary papillary epithelial tumor of right ureter

J Gottheb, *Ztschr f Urol Chir*, vol 11, p 230 (1926)—Female, aged forty-nine years Clinical Findings—Dysuria, pain in left loin and hæmaturia X-ray—Stones in left kidney, enlarged left kidney Cystoscopy—Left ureter orifice hyperæmic, no dye from left kidney Associated Calculi—Stone Pre-operative Diagnosis—Not reported Treatment—Nephrectomy and ureterectomy Pathological Findings—Surgical specimen Left hydro-ureter above the site of the tumor with left hematonephrosis, tumor left ureter extending into retroperitoneal fat, two enlarged lymph-nodes Microscopical—Medullary carcinoma of left ureter

R Glas,⁶¹ *Wien Klin Wchnschr*, vol 1111, p 1145 (1926)—Female, aged seventy-one years Clinical Findings—Pain along sciatic nerve, no history of hæmaturia, bilateral renal enlargement Cystoscopy—Obstruction one centimetre left ureter, catheter passed half-way up right ureter, no dye Result—Died Pathological Findings—Post-mortem Left hydro-nephrosis and hydro-ureter, right hydro-ureter, tumor in middle third of left ureter Microscopical—Carcinoma left ureter

P Blatt,⁶² *Wien Klin Wchnschr*, vol 1111, p 1130 (1926)—Male, aged fifty-five years Clinical Findings—Pain in both loins, hæmaturia, right nephrectomy fifteen months previously, hæmaturia recurred with pain in right lower quadrant radiating to thigh and perineum, tenderness over right ureter with palpation of a cord-like structure along course of right ureter Cystoscopy—Before first operation right hæmaturia after operation papillary growth seen at right ureter orifice Pre-operative Diagnosis—Tumor right kidney, later tumor right ureter Treatment—Nephrectomy, later ureterectomy Result—Died Pathological Findings—Surgical specimen Tumor lower right ureter Microscopical—Medullary carcinoma of right ureter

Judd, Parker and Morse,⁶³ *Surg Clin N Amer*, vol vi, p 1143 (1926)—Male, aged fifty-four years Clinical Findings—Pain in left loin three years before Cystoscopy—Negative, recurrence one year later with loss of weight and hæmaturia, later cystoscopy, small specimen of papillary epithelioma removed from right ureteral orifice Pre-operative Diagnosis—Papillary epithelioma of right ureter Treatment—Prostatectomy followed by nephro-ureterectomy Pathological Findings—Surgical specimen Papillary tumor low down in right ureter Microscopical—Papillary epithelioma of right ureter

K Schule, *Fortschr a d geb d Roentgenatrahlen*, vol 1111, p 825 (1927)—Female, aged sixty-one years Clinical Findings—Intermittent hæmaturia X-ray—Opaque shadow in region of left ureter Cystoscopy—Obstruction at fifteen centimetres left ureter with bleeding, no dye Pre-operative Diagnosis—Tumor of ureter Treatment—Nephrectomy and ureterectomy Result—Died second post-operative day Pathological Findings—Surgical specimen Tumor in lower third of left ureter size of egg, with extension into adjacent structures, left hydro-ureter, left hydronephrosis Microscopical—Solid richly cellular carcinoma of ureter

V C Hunt,⁶⁴ *Surg Clin N Amer*, p 1464, December (1927)—Male, aged sixty-four years Clinical Findings—Irritability of bladder, hæmaturia Pre-operative Diagnosis—Papillary epithelioma of lower third of right ureter Treatment—Nephro-ureterectomy Result—Well Pathological Findings—Surgical specimen Right hydro-ureter, right hydronephrosis, tumor right ureter Microscopical—Papillary epithelioma of right ureter

N F Ockerblad and F C Helwig,⁶⁵ *Jour Urol*, vol 1111, p 451 (1930)—Female aged seventy-five years Clinical Findings—Chills, fever, pyuria, no hæmaturia, cured of carcinoma of nose with X-ray five years before Cystoscopy—Obstruction at right ureter at eight centimetres from bladder, no function X-ray—Mass Pre-operative Diagnosis—Infected hydronephrosis or perinephritic abscess first, then malignant retroperitoneal tumor Treatment—Incision and drainage of lower pole of right kidney, then X-ray treatment Result—Died Pathological Findings—Post-mortem Right hydro-

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nephrosis, right hydro-ureter, enormous tumor infiltrating surrounding structures involving middle third of ureter, tumor penetrating outer coat of duodenum Microscopical—Papillary carcinoma of ureter with metastases of liver

L M Rousselot and J D Lamon,⁶⁹ *Surg Gynec, and Obst*, vol 1, p 1728, January (1930)—Female, aged forty-eight years Clinical Findings—Asthenia, pain left flank, fever and sweats, burning on urination, mass in left upper quadrant Cystoscopy—Floor of bladder pushed up by mass X-ray suggest stone in left kidney Associated Calculi—Stone Pre-operative Diagnosis—Ovarian cyst, left renal calculi, left pyonephrosis and cystitis Treatment—Exploratory laparotomy, dermoid left ovary, cyst opened and drained Poor condition of patient Result—Died thirty-one days later Pathological Findings—Post-mortem Dermoid left ovary, tumor upper left ureter with cysts, left pyonephrosis with calculi, right ureteral calculus and right hydronephrosis Microscopical—Squamous-cell carcinoma of ureter

R D'Aunoy and A Zoeller, *Arch Path*, vol ix, pp 17-30, January (1930)—Clinical Findings—Hæmaturia, negative physical Ureteropyelogram—Ptosis of right kidney, irregularity of filling, dilatation and kinking of right ureter with filling defect 15 centimetres below lower border of ileum Pre-operative Diagnosis—New growth of ureter Treatment—Ureterectomy, forty days, later nephrectomy Pathological Findings—Surgical specimen Tumor of ureter (papillary) Microscopical—Papillary carcinoma and right hydronephrosis

Joseph B Macalpine,⁷⁰ specimen of papillary carcinoma of ureter from a male, aged fifty-eight, *Proc Roy Soc Med*, London, 1889 (1928) Male, aged fifty-eight years Clinical Findings—Pain in right loin and suprapubic region, hæmaturia X-ray—Negative Cystoscopy—Congestion of right ureteral orifice, no dye, obstruction at right ureter five inches from bladder Treatment—Nephrectomy and ureterectomy Pathological Findings—Surgical specimen Tumor left ureter Microscopical—Papillary carcinoma

Harry D Morse,⁷¹ primary papillary epithelioma of the ureter *Canad Med Assoc Jour*, Toronto, vol xv, pp 902-904 (1925)—Male, aged fifty-four years Clinical Findings—Pain in right lumbar region radiating to genitals, hæmaturia August, 1921, stone removed from bladder X-ray—Negative Cystoscopy—Enlarged prostate, no obstruction of ureters, urines negative, function good Right pyelo-ureterogram—Dilatation of pelvis and calyces, two years later painless hæmaturia, loss of weight and strength Cystoscopy—Enlarged gland, right ureteral orifice swollen and covered with small tags Biopsy—Papillary epithelioma Pre-operative Diagnosis—Not stated Treatment—Prostatectomy followed later by hæmaturia Cystoscopy—Obstruction at right ureter at five centimetres, nephro-ureterectomy Pathological Findings—Surgical specimen Right hydronephrosis, right hydro-ureter, pedunculated papilloma in lower right ureter Microscopical—Papillary epithelioma

H E Simon,⁷² papillary epithelioma of the renal pelvis and ureter associated with a huge hydronephrotic sac *Proceedings of staff meetings of The Mayo Clinic*, vol 11, No 36, September 7 (1927)—Male, aged forty-six years Clinical Findings—Hæmaturia gradual enlargement of abdomen X-ray—Negative Cystoscopy—Tumor at right ureteral orifice Biopsy—Squamous-cell epithelioma, right ureter not catheterized, no dye Pre-operative Diagnosis—Papillary epithelioma of right renal pelvis with implants in ureter and bladder and hydronephrosis Treatment—Right nephrectomy and removal of upper two-thirds of ureter, secondary ureterectomy planned Pathological Findings—Right hydronephrosis with tumor in ureter extending into pelvis Microscopical—Squamous-cell epithelioma

P A Rohrer,⁷³ papillary epithelioma of the ureter *Jour Urol*, vol xxiv, No 6, p 639 (1930)—Male, aged forty-nine years Clinical Findings—Left renal colic Cystoscopy—Obstruction at left ureter at one inch from pelvis, blood through catheter, reduced dye in left kidney X-ray—Plain negative Left pyelogram—Hydronephrosis with dilatation of upper part of ureter, following nephrectomy two years later Cysto-

scopy—Small papillary tumor near left ureteral orifice with blood through left ureteral orifice Left ureterogram—Filling defect Pre-operative Diagnosis—Ureteral calculus, later multiple papillomata of left ureter Treatment—Left nephrectomy, two years later hæmaturia and pain in left side, later ureterectomy Result—Well Pathological Findings—Specimen Multiple abscess of ureter three tumors, papillomata in character Microscopical—Papillary epithelioma of ureter

Luigi, Caporale, primary carcinoma of the ureter with atrophic hydronephrosis The Urol and Cut Review, vol \\\v, No 6, p 341, June (1931)—Female, aged seventy-five years Clinical Findings—Intermittent hæmaturia for two months, pain in left flank and dysuria Physical negative Cystoscopy—Polypoid vegetation over left ureteral orifice protruding from ureter each spurt of urine, later going back in again, no dye left X-ray—Negative, obstruction at left ureter at seven centimetres Pre-operative Diagnosis—Papilloma of ureter Treatment—Left nephrectomy and partial ureterectomy Pathological Findings—Surgical specimen Dilated kidney pelvis, dilated ureter, tumor the size of a walnut in lower ureter Microscopical—Papillary carcinoma

Rene Sommer,⁷⁴ primary carcinoma of the ureter with metastatic obstruction of the other ureter Zeitschrift fur Urologie, vol \\\v, p 1 (1932)—Female, aged sixty-one years Clinical Findings—Hæmaturia and tenesmus, sudden anuria four months X-ray—Suggested calculus in lower ureter Cystoscopy—Right ureteral orifice protruding into bladder, obstruction right ureter at orifice, left ureter at one centimetre Pre-operative Diagnosis—Stone right ureter Treatment—Right decapsulation and pyelotomy, kidney small Result—Died of uræmia Pathological Findings—Primary carcinoma middle third of right ureter with deposits in other parts of the ureter, left ureter was also blocked by carcinomatous deposit in centre Microscopical—Papillary carcinoma

V C Hunt,⁷⁵ the necessity for operation in the ureter including ureterectomy subsequent to nephrectomy Jour Urol, vol \\\v, pp 43-54 (Case VI) (1930)—Male, aged forty years Clinical Findings—Intermittent hæmaturia, passed stone seventeen days ago X-ray—Negative Cystoscopy—Neoplasm left ureter orifice, occlusion left ureteral orifice Associated Calculi—Stone Pre-operative Diagnosis—Papillary epithelioma of the ureter Treatment—Left nephrectomy for pyonephrosis, exploration of ureter negative, eleven days later ureterectomy with resection of segment of bladder tumor eight centimetres Pathological Findings—Surgical specimen Pyonephrotic kidney, tumor lower ureter Microscopical—Papillary epithelioma

V C Hunt,⁷⁶ papillary epithelioma of renal pelvis Jour Urol, vol \\\v, p 241 (Case XI) (1927)—Female, aged sixty-five years Clinical Findings—Hæmaturia two weeks, pain in right loin, loss of weight, physical history negative X-ray and Cystoscopy—Negative Right Pvelogram—Bizarre pelvis with filling defect, with moderate dilatation of ureter Pre-operative Diagnosis—Neoplasm of renal pelvis Treatment—Right nephrectomy with removal of upper third of ureter, tumor upper part of ureter, later complete ureterectomy Result—Died Pathological Findings—Surgical specimen First operation squamous-cell carcinoma upper one inch of ureter, later ureterectomy, entire ureter filled with papillary carcinoma, no metastases

P E McCown,⁷⁷ primary carcinoma of the ureter Jour Am Med Assn, vol \\\v No 7 (1930)—Male, aged forty-five years Clinical Findings—Headache and general malaise, physical history negative Cystoscopy—Left ureter obstruction at twenty centimetres X-ray—Left kidney larger than right kidney, hæmorrhage through catheter Pre-operative Diagnosis—Stricture left ureteropelvic juncture, later ureteral tumor Treatment—Left nephrectomy and partial ureterectomy Result—Died third post-operative day Pathological Findings—Surgical specimen Papillary carcinoma upper third of left ureter

F Volante,⁷⁸ primary carcinoma of the ureter Arch Ital d'urol, vol iv, pp 105-132, December (1927)—Male, aged forty-nine years Clinical Findings—Passed calculus at age of fifteen, hæmaturia for eleven years, pain in left flank three years ago Physical

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History—Mass in left hypochondrium X-ray—Negative for stone Cystoscopy—Negative bladder obstruction left ureter at two centimetres Associated Calculi—Calculus Pre-operative Diagnosis—Not stated Treatment—Left nephrectomy and partial ureterectomy later ureterectomy, ureter tumor infiltrating pelvis Result—Died Pathological Findings—Surgical specimen Pyonephrosis and pyo-ureter Post-mortem Papillary carcinoma of left ureter with pseudo-glandular characteristics, metastases in regional nodes, bladder and right lung

L P Player⁷⁷ primary ureteral carcinoma with review of literature with case report Urol and Cutan Rev, vol XXXII, p 7, July (1928)—Female aged sixty-five years Clinical Findings—Hæmaturia two years pain in left side, loss of weight frequency, physical history negative Cystoscopy—Two papillomata in bladder, one near left ureteral orifice obstruction left ureter at sixteen centimetres from bladder bleeding through catheter, no dye left X-ray—Negative Pre-operative Diagnosis—Neoplasm of left ureter probable left hydronephrosis Treatment—Left nephrectomy and partial ureterectomy Pathological Findings—Surgical specimen Hydronephrosis left kidney Microscopical—Papillary epithelioma of ureter with extension into surrounding tissues

B A Thomas,⁸⁰ in discussion of case of P E McCown—Male Clinical Findings—Hæmaturia Cystoscopy—Papilloma, obstruction at ureteral orifice Ureterography—Filling defect Side—Not stated Pre-operative Diagnosis—Papilloma of ureter Treatment—Resection of lower end of ureter and part of bladder and reimplantation of ureter into bladder followed by secondary nephrectomy Result—Recovery Pathological Findings—Surgical specimen Malignant papilloma of ureter

B A Thomas,⁸¹ in discussion of case of P E McCown—Male Clinical Findings—Hæmaturia Cystoscopy—Bloody urine from one ureter Ureterography—Filling defect lower end of ureter Side—Not stated Pre-operative Diagnosis—Papilloma of ureter Treatment—Resection of lower end of ureter and part of bladder and reimplantation of ureter into bladder Pathological Findings—Surgical specimen Malignant papilloma of ureter

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SUPERNUMERARY KIDNEY*

By WILLIAM J. CARSON, M.D.

OF MILWAUKEE, WIS.

TRUE supernumerary kidney is the rarest of the congenital renal anomalies. Martius¹ in 1656 was the first to describe a human subject having two kidneys on one side and a single kidney on the other. Blasius² in 1677 reported the second case. In 1915, Kretschmer^{3, 4} reported his first case, and in 1929 a second case, and, in a complete review of the literature, collected twenty-eight others—making a total of thirty cases, which he summarized according to symptoms, cystoscopical examination, pre-operative diagnosis, operation, pathology, and result. Papin, Bernasconi and Barnard⁵ in 1931 reported a case and collected twenty-seven cases from the literature, which they considered authentic supernumerary kidneys. Lintz,⁶ in 1932, reported a case of bilateral double kidney with duplication of ureters, diagnosed by intravenous pyelography, which has been classified by some as supernumerary. Hicks,⁷ in 1932 resected the upper division of a supernumerary fused kidney. Pain and Eisendrath,⁸ in their classification of renal and ureteral anomalies, in 1927, describe four types of multiple kidneys, *ie* (excess or supernumerary)

(1) Pseudo double kidney, *ie* single mass of parenchyme but two pelves and a single ureter

(2) Two kidneys with two ureters uniting to form a single ureter

(3) Two kidneys with two ureters opening separately into bladder

(4) Two kidneys with ureter of upper opening into lower

F. P. Johnson and Young⁹ describe two varieties, free and fused

(1) *Free* supernumerary kidneys are to be considered only in those cases in which there are found two entirely separate kidneys on one side with a normal kidney on the other. The supernumerary kidney always lies at a lower level than the normal one, and is frequently found in the lower iliac region or pelvis. Its form is usually somewhat distorted, its size smaller than normal. The usual explanation is that it is the resultant of a supernumerary ureteral bud. That it may also be due to the complete splitting of the renal anlage as in a case of double kidney is obvious, since cases of free supernumerary kidney have been described where the splitting of the ureter was incomplete.

(2) *Fused* supernumerary kidney is usually found in cases of double ureter and pelvis. The kidney is elongated and oftentimes shows evidence of a transverse sulcus which incompletely divides it into two parts. Sometimes the sulcus is quite shallow or not indicated at all, at other times it is deep, leaving only a small bridge of renal parenchyma or connective tissue binding the two together. An analysis of this condition will show that it is quite

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similar to that of free supernumerary kidney. The difference being merely one of degree. Embryologically such kidneys are the result of splitting of a ureteral bud or the development of two separate ureteral buds, with a single or incompletely divided primitive metanephrogenic cap.

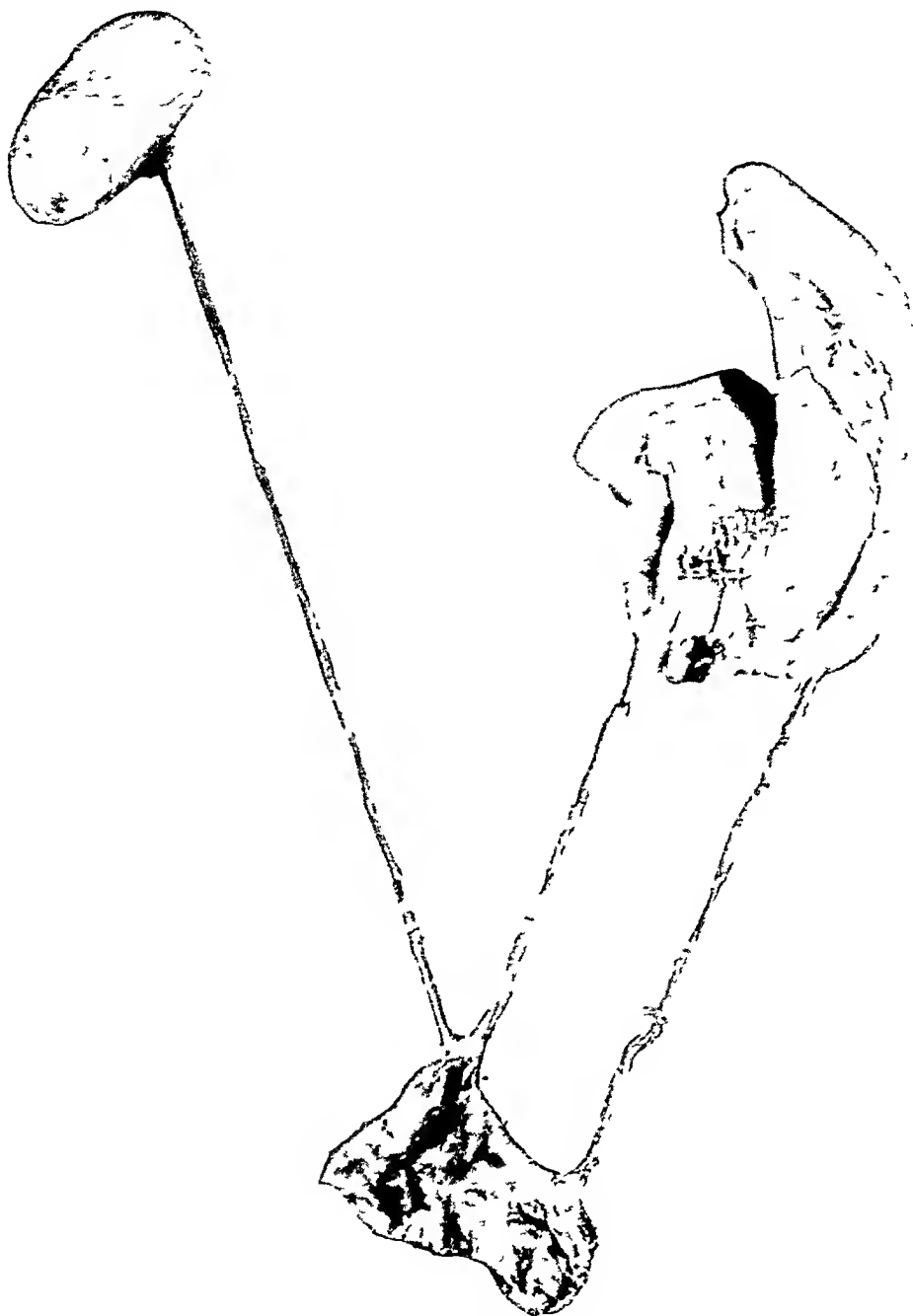


FIG. 1.—Photograph of pathological specimen (No. E69, Department of Pathology, University of Maryland, Md.), showing fused supernumerary kidney, left with separate blood supply, renal pelvis and ureter which crosses the midline and enters the right side of the bladder 5 cm. mesial to the right ureter. The fundus of the bladder is reflected downwards to show relationship of ureters as they enter the bladder.

I report an example of the latter type from the pathological museum of the University of Maryland, the photograph of which specimen is attached (Fig. 1).

WILLIAM J CARSON

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THE TREATMENT OF VARICOSE VEINS

A STUDY BASED UPON A SERIES OF MORE THAN 35,000 INJECTIONS OF VARIOUS SCLEROSING SOLUTIONS GIVEN IN 3,164 CASES, AND 293 CASES OF EXTENSIVE AND RECURRENT VARICOSE VEINS TREATED BY PRELIMINARY AMBULATORY LIGATION AND SUBSEQUENT INJECTIONS

BY WILLIAM M COOPER, M D

OF NEW YORK, N Y

FROM THE DEPARTMENT OF SURGERY OF THE NEW YORK POLYCLINIC MEDICAL SCHOOL AND HOSPITAL, SERVICE OF DR JOHN J MCGRATH

THE treatment of varicose veins by the injection or sclerosing method, while a most valuable addition to our therapeutic armamentarium, is not the "cure-all" it promised to be when first presented to the medical profession of this country

The majority of varicose-vein patients may be treated successfully by the injection method alone. However, there is a large group of patients which cannot be successfully treated by this method unless preliminary ligation or ligations are performed.

While this statement may appear somewhat dogmatic, it becomes an axiom to anyone engaged on a large scale in the treatment of varicose-vein patients. There is sufficient evidence in the recent literature to support this. de Takats,^{1,2,3} Cooper,⁴ Scheiber,⁵ and Moszkowicz⁶ have all reported on a sufficiently large series of cases to warrant such conclusions. As a matter of fact, one may go back as far as 1811 when Everard Home⁷ noted the salutary effects of "including the saphena magna in a ligature above the knee in cases of chronic varicose ulcers associated with status varicosus."

According to de Takats,¹ the pressure in a valveless vein may be as high as 210 centimetres of water when standing. Ligation, therefore, reduces the pressure in a valveless vein and protects the thrombus formed after the injection from recanalizing.

Curiously, even radical excision of a varicose saphena magna is frequently followed by recurrence unless high ligation of the vein is practiced. Homans⁸ and Trout⁹ report such occurrences.

At this point, I wish to stress again the importance of the same principle in the injection method of treatment, namely, thorough obliteration of a varicose internal saphenous vein is frequently followed by recurrence unless high ligation is performed as a preliminary measure.

Assuming that a patient presents no contra-indications^{10, 11, 4} to the injection treatment, and patency of the deep veins has been ascertained by means of the von Perthe test,^{9, 12} or one of its modifications, how is one to proceed in the treatment of the case?

It is the writer's opinion that the first and most important step in this work is the classification of the patient by means of the Trendelenburg test so that the sources or points of reverse flow from the deep veins into the superficial veins can be accurately localized.

The correct interpretation of this test depends upon one's understanding of the dynamic principles of the normal venous flow, and the changes in such principles in status varicosus. Any attempt to proceed with treatment without the knowledge of the Trendelenburg status of a patient can lead only to indifferent results and recurrences.

The Trendelenburg Phenomenon or Test—Berntsen¹³ classifies the Trendelenburg phenomenon into four groups

(a) Trendelenburg *positive* when the reverse flow from the deep veins into the saphena magna takes place at the saphenofemoral junction, or through one of the larger communicating veins in the lower part of the thigh

(b) Trendelenburg *negative* when the back flow from the deep veins takes place through the incompetent communicating veins in the leg while the valves in the saphena magna in the thigh remain intact and competent

(c) Trendelenburg *double* This group embraces both of the aforementioned classes and is usually found in cases of very extensive varicose-vein formation. In this class there is a reverse flow of blood downward from the saphenofemoral junction as well as a marked reverse flow outward through the communicating veins in the leg

(d) Trendelenburg *nil* In this group there is neither a reverse flow from the saphenofemoral junction nor through the communicating veins in the leg. The veins in this group have dilated walls but the valve edges coapt and are competent, thus preventing back flow. This phenomenon represents an early stage in the development of varicose veins with dilatation of the vein walls in the presence of competent valves. The dilatation may finally develop so widely that the valves cannot coapt their edges and become incompetent, in which case the reverse flow develops and one of the other Trendelenburg states supervenes.

Ochsner¹⁴ elicits the Trendelenburg sign as follows. The patient stands, allowing the saphena magna to fill and become prominent. Make firm pressure with the thumb of one hand on the lower end of the saphena magna, the blood is then stripped upward and if the vein remains collapsed between succeeding groups of valves, the valves are competent and the Trendelenburg sign is absent. If the veins fill from above, it is evident that the valves are incompetent and the Trendelenburg sign is positive or present.

Another method for demonstrating the Trendelenburg phenomenon is described by McPheeters¹⁵

My method for demonstrating the Trendelenburg phenomenon is simple and for all practical purposes very satisfactory. The patient is recumbent and the limb to be examined is elevated above the body, thus causing the veins to empty and collapse. With the limb elevated, a series of tourniquets are then applied from the knee to the groin at intervals of about three inches with sufficient pressure only to block the flow in the saphena magna. The patient then stands on a platform. If the varices in the leg are large and yet fill very slowly and then only under slight tension, one may be certain that there is no back flow from the deep veins of the lower leg into the superficial veins through an incompetent communicating vein. With the patient still standing the tourniquets are removed, one at a time, from below upward. If the veins below any tourniquet remain collapsed the reverse flow must take place at some point above it. If the veins remain collapsed to the highest tourniquet, the only source of reverse flow must be the femoral vein at the saphenofemoral junction, through an incompetent saphena magna. This phenomenon is

classed as Trendelenburg *positive*. It is further proven when the highest tourniquet is removed and all the veins below it in the thigh and leg are seen to fill very suddenly and completely. The patient is classed as Trendelenburg *negative* if the veins of the leg fill very suddenly and under great tension when the patient stands with the tourniquets applied to the thigh. The Trendelenburg *double* group comprises those cases in which the combination of Trendelenburg positive and negative exists. There is not only a reflux of blood from the saphenofemoral junction through the saphena magna, but also from the deep veins through one or more of the communicating veins in the leg. When the tourniquets are applied and the patient is asked to stand, a rather rapid filling of the veins in the leg will be noticed. The tourniquets are then quickly removed and if the veins become more tense immediately after, one may surmise that the valves of the saphena magna are also incompetent. The Trendelenburg *nil* case represents an early stage in the development of varicose veins, with dilatation of the vein wall in the presence of competent valves. There is no demonstrable reverse flow in this group.

Indications for Ligation—Having determined the Trendelenburg status of a patient one can readily decide whether or not to perform the preliminary ligation.

Trendelenburg *positive* cases are those in which the reflux of blood through the saphena magna in the thigh is marked and the valves, therefore, are incompetent. Ligation at the highest palpable point in the thigh, or at the fossa ovalis, is definitely indicated.

Trendelenburg *negative* cases are those in which the reflux of blood from the deep veins takes place through incompetent communicating vein or veins in the leg, the so-called "blow-out" veins of McPheeters. In this group one may proceed directly with the injection treatment without preliminary ligation. If, however, the veins are very large, it is my practice to perform a preliminary ligation at the highest palpable point in the leg at which a reverse flow can be demonstrated. While some workers may not agree with me as to the need or advisability of an ambulatory ligation in this type of case, I have found the procedure worth while and of definite value.

In the Trendelenburg *double* group and especially those with large and extensive varices, it is my practice to perform multiple ligations at all the demonstrable points of back flow. Formerly, this type of case was subjected to radical operative procedures, but in my hands multiple ligations with subsequent sclerosing injections have proven most successful.

Trendelenburg *nil* cases are injected without preliminary ligation.

How to Select the Proper Point for Ligation—I usually combine several methods for determining at which point or points ligation should be performed.

The first method, that of Ochsner,¹⁴ is described elsewhere in this paper. When performing this test, carefully observe each segment of vein as it is being stripped upwards. If the veins below the point at which finger pressure

is being applied should suddenly distend, it is evident that reverse flow has occurred and the site at which this happens is selected for ligation.

The second method, that of the writer, is carried out with the tourniquets applied to the limb from the knee to the groin at intervals of about three inches. The tourniquets are removed, one at a time, from below upward. If the veins suddenly distend when any one of the tourniquets is removed, then the source of the backflow is somewhere between this tourniquet and the one next higher to it. This test is repeated with the tourniquets applied a little closer so that the exact point of reverse flow may be localized. If the veins remain collapsed until the highest tourniquet is removed, and then suddenly fill and distend, ligation must be performed at the fossa ovalis or very slightly distal to the saphenofemoral junction.

The third method, known as McPheeters' percussion test, is a very convenient method for "tracking" or locating the saphena magna in the thigh, especially in obese individuals in whom the upper portion of the vein may not be easily visualized or palpated. The patient stands. Gently tap the prominent veins in the leg with the fingers of one hand. This will produce a pulse or pulse wave which is transmitted to the saphena magna in the thigh. By gently palpating along the course of the vein in the thigh with the fingers of the other hand, the position of the saphena magna may be accurately mapped out. The highest point at which the pulse wave is perceived is the site usually selected for operation. As a rule I do not rely on this method alone, but supplement it with the tourniquet test for greater accuracy in selecting the point for ligation.

After the site for operation has been selected, the skin should be marked directly over the vein and parallel to it for about one inch with an indelible pencil, a marking device preferred because of its convenience and the mark made with it is not easily removed by the usual methods of pre-operative skin preparation.

Technic of Operation—The site for operation has been carefully selected by one or more of the methods heretofore described.

The thigh or leg is shaved and the patient is placed in the recumbent posture in which position I prefer to operate, although de Takats^{1 2} chooses to operate with the patient standing. The pre-operative skin preparation consists of painting with tincture of iodine followed by alcohol, or with a 3 per cent alcoholic solution of picric acid. A ½ per cent solution of novocaine is then injected into the skin and subcutaneous tissue in a line which crosses the marked vein at a right angle. Care is taken before the novocaine is injected to see that a vein has not been entered, since novocaine intravenously will cause a severe reaction and shock. This may be done by drawing up on the plunger of the syringe to ascertain the position of the needle before each injection. The skin and subcutaneous tissue are then incised along the line of novocaine infiltration and the deeper fat layer is separated with a blunt instrument such as a hæmostat. The vein should be readily recognized in the deeper layer of the fat or directly under it. The fascia of the vein is stripped off and the vein is carefully picked up with anatomical forceps. A hæmostat is then gently worked under the vein and the blades are spread, thus freeing the vein from its sheath or fascia. The vein is ligated with chromic No. 1 catgut at two points about one inch apart and the intervening segment of vein is excised. Any com-

TREATMENT OF VARICOSE VEINS

municating or collateral veins connected with the segment to be excised are also carefully ligated and cut. The vein stumps are dropped into the wound, the fascia is apposed with one or two catgut sutures and the skin is closed with several dermal or silk sutures, or skin clips.

In order to prevent massive thrombosis in the vein below the ligature, I apply a firm, spiral elastic bandage (the new Ace No 8 is excellent for this purpose) from the ankle to the groin before the patient is allowed to alight from the operating table. The patient is instructed to apply the bandage each morning before allowing the limb to assume a dependent position.

The after treatment is no different from that of any other operative wound, the sutures being removed on the fifth to seventh day as a rule, at which time I usually begin the injections of sclerosing solution.

If the vein is ligated at the proper point, the first thing noticed when the patient alights from the operating table is the almost complete collapse of the veins below the ligature and the patient will promptly comment on the feeling of lightness in the limb which formerly was heavy and tired.

Choice of Sclerosing Solution—The recent literature on sclerosing solutions for the injection treatment of varicose veins is replete with the advantages and disadvantages of each agent.

Perhaps the most widely used sclerosing agent of all those recently offered is sodium morrhuate 5 per cent. In December, 1932, I¹⁶ reported on the use of this substance in the treatment of more than 600 patients with approximately 4,000 injections. Up to the present time I have used sodium morrhuate 5 per cent in a considerably larger series of cases. The results I have obtained with it are excellent and agree in almost all respects with the results reported by Levi,¹⁷ Smith,¹⁸ Tunick and Nach,¹⁹ and Higgins and Kittel.²⁰

At the present time, I am also using a new combination of sodium morrhuate 5 per cent with quinine alkaloid 2 per cent and benzyl alcohol 2 per cent, but I have used this new preparation in too small a series of cases to warrant any definite conclusions.

Technic of Injection with Sodium Morrhuate 5 Per Cent—The quantity of sodium morrhuate 5 per cent that may be injected at one sitting should never exceed five cubic centimetres.

The skin at the site of injection is prepared with tincture of iodine followed by alcohol.

Those cases presenting very large varices are treated according to the method of McPheeters²¹ namely, isolation of a segment of the vein between tourniquets after the vein is emptied by elevation of the limb, the patient being in a recumbent position.

The vast majority of patients, however, are treated while standing on a table or platform about twenty-seven inches high. Standing renders the veins more prominent. A five-cubic centimetre Luer syringe fitted with a sharp, short bevel, 25-gauge needle is then gently but firmly pushed through the skin into the vein with needle pointed upward. The position of the needle in the vein is quickly ascertained by the presence of blood which trickles through the needle into the syringe. If the vein is small the injection is given without further preparation, if medium sized or larger, the vein is milked with the thumb and middle finger of the left hand, or by an assistant, after which the injection is given.

I usually inject from 0.5 to 3 cubic centimetres of the solution at any one site and as a rule place the first injection at the highest point in any vein or group of veins.

As soon as the desired quantity of solution is injected a tonsil sponge moistened with alcohol is placed firmly over the site of puncture and the needle is withdrawn. An adhesive strap about seven inches long and one inch wide is then placed over the sponge, binding it firmly over the injected area. The patient is instructed to remove the dressing after forty-eight hours and not to massage or rub the limb at the point injected.

Injections may be repeated every second day and in the intervals between treatments the limb should be kept snugly encased in a spiral elastic bandage

Comment—During the past few years I have performed the Trendelenburg operation (ambulatory) as a preliminary measure in 293 cases and I have given more than 35,000 injections of various sclerosing solutions in the treatment of varicose veins

The patients selected for preliminary ligation were those who presented very large and extensive varices with marked reverse or back flow as well as those with recurrent veins. My experience with this type of case, treated with injections alone, had proved somewhat disappointing, chiefly from the standpoint of recurrence. It became apparent to me several years ago that a permanent cure could not be effected by injections alone and that the ambulatory ligation, so warmly advocated by de Takats, was a sound procedure based upon a logical consideration of the altered dynamic principles of the blood flow in the veins of the lower extremity.

The patients selected for injections without preliminary ligation were those who presented either larger or small varices with no evidence of marked reverse flow.

SUMMARY—Sodium morrhuate in 5 per cent strength will not cause toxic symptoms when used in the proper quantity.

Sodium morrhuate will not produce an ulcer or slough if accidentally injected into the perivenous or subcutaneous tissues.

Sodium morrhuate will not produce an infectious phlebitis if a proper, aseptic technic is observed.

The objectionable symptoms (pain, cramp and systemic reactions) and sequelæ (sloughs, residual discoloration and nodulation) resulting from the injection of the other solutions will not occur with the use of sodium morrhuate.

Five per cent sodium morrhuate meets with all the requirements for a safe and effective sclerosing agent in the injection treatment of varicose veins.

Not a single instance of recurrence was noted in a series of 293 cases of extensive and recurrent varicose veins treated by preliminary ambulatory ligation and subsequent injections.

All patients were ambulatory and no time was lost from gainful work.

Immediate symptomatic relief was noted in nearly every case after ligation.

Following ligation, complete thrombosis or occlusion was noted in 4 per cent of the cases, so that no injections were necessary. A radical cure was thus obtained by this simple procedure alone.

After ligation the veins are partially collapsed so that smaller quantities of the sclerosing solution can be used with as great or greater effect, than when the vein is distended with blood.

The number of injections required for satisfactory obliteration of varicose veins after ligation is markedly diminished.

The sclerosed vein after ligation and injections disappears more quickly and completely than when treated by injections alone.

TREATMENT OF VARICOSE VEINS

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TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD APRIL 12, 1933

The President, DR JOHN DOUGLAS, in the Chair

TONSILLECTOMY, BRONCHIECTASIS, LOBECTOMY

DR FRANK B BERRY presented a woman, aged thirty-nine, who was admitted to Bellevue Hospital May 25, 1932

In the preceding January, 1932, she had a tonsillectomy Three to five days after the operation a large swelling developed in the right tonsillar region This drained into the mouth and about the same time she began to cough and bring up large quantities of foul sputum She has had two or three small hæmoptyses and lost eighteen pounds in weight She left the hospital after three months Since then she has regained ten pounds but has continued to expectorate Sputum now amounts to twelve ounces a day and she complains of slight pain in the left back

Physical Examination—Negative except for left chest where there was dullness from the second to eighth spaces posteriorly and over the middle third anteriorly Over this area there was bronchovesicular breathing and a few râles were heard at the base The bronchoscope showed pus from left lower lobe bronchus, with bronchiectasis of left lower lobe

Course—Pneumothorax on left started June 2, 1932 and left phrenic crushed on the same date First-stage lobectomy June 14 Portion of ninth rib removed and sixth seventh and eighth ribs divided at angles Chest opened Upper lobe collapsed This and parietal pleura rubbed with gauze Lower lobe found adherent to pericardium and diaphragm, this was completely mobilized Wound closed without drainage June 15 200 cubic centimetres bloody fluid aspirated June 16 500 cubic centimetres bloody fluid aspirated Smooth convalescence

June 28—Second stage Both lobes adherent to chest-wall Lower lobe mobilized Payer clamp applied at root and lobe amputated Stump transfixed and ligated and wound packed loosely with iodoform gauze Temperature 101° and pulse 130 the night after operation Five hundred cubic centimetres blood given Smooth convalescence and patient returned to chest service August 16, 1932, with wound healed and no cough

December, 1932—Follow-up Occasional dry cough Lungs clear and resonant

TUBERCULOSIS THORACOPLASTY HÆMORRHAGES TWO YEARS LATER EMERGENCY THORACOPLASTY

DOCTOR BERRY presented a woman, aged twenty-four, who was admitted to Bellevue Hospital January 15, 1931 She had been coughing blood for two days She had a history of tuberculosis for five years Thoracoplasty in three stages at another hospital in 1929 Improved for a short time but cough returned and since has been a semi-invalid Three days before admission she had an hæmoptysis of several ounces and this was repeated the day before admission

PYOGENIC-TUBERCULOUS PYOPNEUMOTHORAX

Sputum positive for tubercle bacilli X-ray showed inadequate thoracoplasty with a fibrocaseous lesion

Course—Hæmoptysis continued several times a day in one- to three-ounce amounts Temperature dropped to 100° Phrenicectomy January 21, 1931, without benefit Hæmoptysis increased to four- to six-ounce amounts and tended to recur every other day

January 27, 1931, upper stage thoracoplasty under local anæsthesia Patient had an hæmoptysis and a convulsion during the operation Former operation revised and large segments of the first six ribs removed

Temperature to 104° and pulse to 140 immediately following operation but dropped promptly to 102° and 120 and continued down Convalescence smooth although there were several small hæmoptyses during the first few days Transfusion

Second stage of thoracoplasty revision performed March 3, 1931, with removal of lower ribs This was preceded by a transfusion of 500 cubic centimetres Smooth convalescence and wound healed well Returned to chest service and from there went to a sanatorium for further convalescence Sputum became negative and has remained so Now has very little cough or sputum and is allowed to do as she wishes

Case presented to show the failure of an inadequate thoracoplasty and the response to a proper type of thoracoplasty which was performed as a life-saving procedure for continuing hæmoptyses

PYOGENIC-TUBERCULOUS PYOPNEUMOTHORAX WITH BRONCHIAL FISTULA

DOCTOR BERRY presented a man, twenty-four years of age, who was admitted to Bellevue Hospital August 20, 1929 with cough and expectoration, and a history of tuberculosis for nineteen months before admission Lesion confined to left side and pneumothorax started Fluid present since inception of treatment Three months before admission he began to bring up small amounts of non-foul bad tasting fluid on stooping over During this time lost ten pounds Gentian violet injected into pleural cavity is brought up in the sputum

Physical examination, negative except for signs of a pneumothorax with effusion in left chest Sputum positive for tubercle bacilli Thick green pus aspirated from chest X-ray in complete collapse of left lung with fluid present Right lung clear

Course—Patient did poorly and September 19, 1929, a catheter was inserted through the ninth space into the left chest Tube drained well and chest was irrigated gently with mercurochrome and boric acid

October 3, 1929, extensive resection of upper four ribs under local anæsthesia Wound healed well and patient did well although he ran a septic temperature, at times to 102° and 103°

November 12, 1929, extensive resection of third to eighth ribs inclusive Patient did well and temperature and pulse gradually subsided except for occasional flares

December 28, 1929, ninth to eleventh ribs inclusive resected Bronchial fistula still open Wound healed well about sinus tract to empyema cavity From January to late March 1930, he ran a low-grade, irregular temperature thought to be due to a slight infiltration of the right middle lobe In October, 1929, weight was 112 pounds By April 1930 it was 130 pounds By August, 1931, his weight was 148 pounds Still wearing a tube Sputum negative Wound closed in October, 1930

January 13, 1931 Two small abscesses developed recently near old sinus tract Operation showed a small pleural cavity in axilla Third to seventh anterior rib ends removed Wound closed and drained Did well and went home on the eighteenth day Two more small operations of the Schede type were necessary before permanent closure was effected, one November 9, 1931 and the last, his sixth, on March 6, 1932 This consisted of merely laying open a short sinus tract This healed in May, 1932 Since then he has remained well, weighs about 180 pounds, and is working

Case presented because it presents one of the worst complications of pulmonary tuberculosis—spontaneous rupture of the lung with the development of a bronchial fistula and pyogenically infected tuberculosis empyema This responded to radical surgery and then persistence in pursuing and eradicating the resultant sinus In addition he developed and healed a small area of tuberculosis on the opposite side during his convalescence

DR HOWARD LILIENTHAL called attention to the rapid onset, in the first case, of the coughing up of pus It is rare to have the symptoms come on so suddenly as they usually occur about two weeks after tonsillectomy As to the various methods of drainage In this case there was no drainage after the first stage lobectomy After the second stage when the lobe was excised the wound was packed loosely with iodoform gauze Doctor Lilienthal called attention to the advantage in lobectomy of suction with no packing after the lobe has been removed He uses a valve suction and there has been no mortality among his last four cases Two are entirely well and two have a bronchial fistula although this was present before he operated on them and the fistulæ may be expected to close spontaneously In Doctor Berry's third case, Doctor Lilienthal called attention to the advantage of carefully graded work in thoracoplastic operations He does not believe it is necessary to take out large sections of the first rib, there are certain disadvantages in doing that It takes longer and there is always the danger of injuring one of the large vessels as they cross over the first rib After it has been denuded of periosteum it gives a good support for the operator's hand when pushing down the pulmonary apex Regarding the case of the woman who had the hæmorrhages, Doctor Lilienthal thought it sometimes wise in these cases to have the patient bronchoscoped to show where the hæmorrhage is coming from, this may make a difference in what is to be done The blood may come from a bleeding ulcer of the bronchus As to the use of thoracoplasty for the checking of hæmorrhage, this is an excellent measure In a case with active hæmorrhage brought in an ambulance a distance of one hundred miles, Doctor Lilienthal did a first-stage (upper) thoracoplasty and the bleeding immediately ceased and did not recur Regarding the convulsion which the second patient had during the upper stage of the operation, Doctor Lilienthal believes in operating in all these cases where there is manipulation of the pleura with the patient's head lower than his chest Most of these convulsions, probably all of them, occur from emboli and usually air emboli in the brain (Schlaepfer's theory) As to the shortness of breath, that

GALL-STONES IN WOMEN

is not due to the amount of lung put out of commission. It may be caused by a pull on the mediastinal structures, and it is usually cardiac.

GALL-STONES IN WOMEN

DR EDWARD D TRUESDELL presented four patients illustrating features of his paper "Incidental Gall-stones in Women" read before the New York Surgical Society a year ago.

CASE I—Was a young woman, seventeen years of age, who was referred to the Lincoln Hospital in August, 1932, by her family physician as a case of acute appendicitis. There had been a history of five months of attacks of abdominal pain. This diagnosis was concurred in by the admitting physician at the hospital, two members of the surgical interne staff, an associate attending surgeon and the assistant attending surgeon who operated upon the patient. At operation a greatly distended gall-bladder was uncovered containing a large quantity of turbid fluid, a dozen or fifteen small stones and putty-like material. It was thought best to drain the gall-bladder at the time. A month later the gall-bladder was removed by the speaker because of continued pain, evidences of persisting inflammation and because it was felt that it would be necessary to do so eventually in any case. Doctor Truesdell presented the case as an example of gall-stones in a young woman of seventeen years where, because of the patient's age, it was generally assumed that the symptoms were those of appendicitis and disease of the gall-bladder was not even considered. It was his opinion that many patients developing symptoms of gall-bladder disease during middle-age were possessed of gall-stones that had had their incipency during the second and third decades of life, and had remained quiescent for long periods of time, as brought out in his paper. While cases of gall-stones under twenty years of age are reported from time to time, these represent chiefly the cases that have developed acute symptoms and must be considered as only a proportion of the number of cases actually originating and existing during this period of life. He felt that gall-stones might be more frequently diagnosed in the younger patients were the possibility of the existence of this condition held more prominently in mind. It would seem probable in the case of the patient presented that the gall-bladder might have been palpated under ether relaxation had the attempt been made.

CASE II—Was a woman, forty-three years of age, who had married at the age of fourteen years and had had seven pregnancies, three of these before the age of twenty years. Symptoms of gall-stones had developed at the age of thirty years, which persisted at intervals for six years when she was operated upon for the removal of her gall-bladder. This was said to have contained gall-stones and to have been removed. The operation had not been performed during an acute attack. One year after this operation, or six years ago, her symptoms recurred and gradually increased in severity, having been exceedingly severe during the past few months. At operation the gall-bladder fossa was found filled with omental adhesions which also extended to the region of the gastrohepatic omentum and duodenum. These were separated with some difficulty and a small pouch-like structure uncovered containing a medium-sized round gall-stone. This was continuous with a normal appearing cystic duct. This case was presented as an example of marriage with multiple pregnancies at an early age and the probable development of gall-bladder disease during the second or third decade of life even though definite symptoms of gall-stones did not appear until the patient was thirty years old. The case was of particular interest to him as an example of incomplete cholecystectomy, the ampulla of the gall-bladder and a stone the size of a small marble having been left behind, as was no doubt the case in view of the normal cystic duct. In his paper of the year before, Doctor Truesdell had expressed himself as opposed to the removal of the gall-bladder when this operation was superimposed upon any other of considerable extent. He felt that operations upon the gall-bladder were of sufficient importance and difficulty to entitle them to a separate procedure in the majority of cases and should not be merely incidental to some other operation when

the time already consumed, and the patient's condition might be a cause of hasty and inadequate procedure. Gall-bladder operations not infrequently turn out to be difficult and complicated which when begun had seemed to be simple, and it is of great importance that at the first attack upon the biliary structures a complete and satisfactory operation be performed through an incision advantageously located, and not through an incision located for some other operation even if extensively and unduly extended.

CASE III—Was a woman twenty-eight years of age who had been married at twenty but had had no pregnancies. At the age of twenty-two years she developed quite typical attacks of biliary colic marked by severe abdominal pain, nausea and vomiting. Five weeks before, she had removed her gall-bladder containing ten medium-sized faceted gall-stones and fragments of still others. Four years ago, or two years after the development of her gall-bladder symptoms, she had undergone a gynecological operation, the appendix was removed and also a cyst of the ovary, and a ventrosuspension performed. It was reported that the gall-bladder had been palpated through the lower abdominal incision and that no gall-stones had been felt, although it would seem most improbable that they were not present at the time.

CASE IV—Was a woman twenty-four years of age who had been married at eighteen years and had had two pregnancies. At the age of twenty-three years, or one year ago, she began to have attacks of acute abdominal pain. These attacks persisting for eight months, she had undergone a gynecological operation in September, 1932 the appendix being removed. It was reported that the gall-bladder had been palpated through the lower abdominal incision but that no gall-stones had been felt. The attacks of pain continuing, she was admitted to the Lincoln Hospital in January, 1933. Through a gall-bladder incision the gall-bladder was found to be free of adhesions, although the gall-bladder wall showed evidences of pathology. Only after prolonged and very careful palpation of the gall-bladder was it possible to discover what was thought to be a solitary small, shot-like stone. After the removal the gall-bladder was found to contain some sixty-five very small round stones. Even with the advantage of an incision directly over the gall-bladder, the stones had almost escaped detection because of a rather large gall-bladder with a considerably thickened wall and a quantity of very thick mucilaginous bile which did not escape from the gall-bladder upon moderate pressure.

These last two cases were presented to show two young women who had married early in life, one of whom had had pregnancies and both of whom had developed gall-bladder symptoms at an early age. In both cases the gall-bladder had been palpated through a lower abdominal incision and in neither case had gall-stones been detected. It would seem that in the first case stones readily palpable had escaped detection because of unfamiliarity with the manoeuvre, but in the second case stones barely palpable through a gall-bladder incision might readily have escaped detection by palpation through an incision in the lower half of the abdomen. In his paper, Doctor Truesdell had reported thirty-one women possessed of gall-stones among 350 women whose gall-bladders he had palpated during the course of an abdominal operation. In none of these had the presence of gall-stones been suspected before operation. This was an incidence of approximately 9 per cent of the cases examined which had seemed exceedingly high. However it was maintained that this might be even lower than the actual occurrence of gall-stones among these 350 patients, since it would seem not improbable that gall-stones present had escaped detection by palpation alone in one or more cases, particularly when the incision was not advantageously located for this procedure. It was also pointed out that six of these thirty-one

women, or 19 per cent, of the entire number, were twenty-nine years of age or younger. This would seem to support the supposition that gall-stones had their origin in the latter part of the second decade or in the early part of the third more frequently than realized, and that one or more pregnancies early in life might favor the development of gall-stones even if not being directly responsible for them.

DR JOSHUA E. SWEET said that the one thought that occurred to him was that Doctor Truesdell, in presenting his interesting cases, said that he found "gall-stones." One can think, off-hand, of at least six different kinds of gall-stones which would indicate at least six different varieties of metabolic disturbances resulting in gall-stones. For fifty years surgeons have been in the habit of sending their gall-bladders to a pathologist who has sectioned the gall-bladder, returned a microscopical report, and apparently poured the gall-stones down the sink. The speaker thought the surgeon should be able to write the microscopical report himself after his study of the gall-bladder during removal, and so at least save the patient some of the high cost of medical care. In the time thus saved to a pathologist, he might pour the gall-bladder down the sink, and learn more by a study of the stones.

DR HENRY F. GRAHAM remarked that Doctor Truesdell had emphasized the fact that many patients were young. On the speaker's service recently there was a patient nine years of age with acute cholecystitis. There are cases in the records of gall-stones in the newborn so age is not a significant factor. As to the etiology, Joshua Sweet has said he believes the metabolism of vitamins comes into this. Many consider it a question of infection of some kind in every case. One man who has done a great deal of experimenting found that 50 per cent of women who are pregnant show a bacilluria. The wisdom of performing only one operation at a time in a case where two operable conditions exist has been shown by The Mayo Clinic, the mortality was doubled when two operations were done at one time. As to the technic, if the gall-bladder is going to be examined for stones, it is better to do it at the beginning of the operation instead of at the close because of the increased danger of infection. Also if novocaine is used for spinal anæsthesia it gives the patient a chance to come out while the surgeon is examining in the upper abdomen.

DR HOWARD LILIENTHAL said that some years ago he had a girl patient eleven years of age whose gall-bladder he removed because of multiple pigment stones.

DOCTOR TRUESDELL, in closing the discussion, said that on the basis of the experience obtained in collecting the material for his paper he had become greatly impressed with the tendency of gall-stones to remain quiescent in the gall-bladder for considerable periods of time. He believed for this reason that cases of gall-stones encountered from time to time during the early years of life were, because of their acute symptoms, only a part of those

originating and existing during this period, many not asserting themselves until the fourth or fifth decades. He had also been impressed with the ease with which gall-stones escaped detection by palpation through an abdominal incision, such factors as the size of the gall-bladder, the condition of its wall, the size and number of the stones, the consistency of the bile, and the ease or difficulty with which the gall-bladder emptied upon pressure, all having much to do with the detection of stones present.

HÆMANGIOMA OF SPLEEN

DR OTTO C. PICKHARDT presented a man, thirty-three years of age, who was admitted to Lenox Hill Hospital in September, 1929. He had enjoyed good health up to about a year before admission. During the year of 1928, he had had mild attacks of abdominal discomfort described as cramps in the lower abdomen. At first these attacks occurred several times a week, later becoming less frequent and occurring only several times a month. About six months before entering the hospital he had noticed swelling of the ankles and puffiness of the eyelids and at about the same time a yellow tinge to the skin had become apparent. This was followed by gradual general weakness for which he sought relief. Another symptom that to him was very important was his impotence.

On physical examination a mass was found occupying almost the entire left side of the abdomen and extending as far as McBurney's point on the right side. In the left upper quadrant there was a definite bulging of the mass which shaded off to a deep oblique groove in the left lower abdomen. The mass was moderately movable and not tender.

On X-ray examination this mass was found to have pushed the stomach and descending colon to the right. No organic disease was noted in the gastro-intestinal tract. A pyelogram demonstrated a normal left kidney outline and normal filling of the calyces. Chest examination was negative.

The blood count on admission was 3,440,000 red blood cells with 55 per cent hæmoglobin. The leucocyte count was normal. Blood smear examination showed anisocytosis, poikilocytosis and polychromatophilia. Wassermann negative, blood grouping II Jansky, urine and blood chemistry essentially normal, icterus index normal, temperature normal.

Blood-picture did not help in making a diagnosis. A provisional diagnosis of tumor of spleen was made and five deep X-ray therapy treatments were given. There was immediate recession of the size of the tumor, but this lasted only a short time and within a few weeks the mass had grown to its former tremendous size.

In order to prepare for operation, a transfusion of 500 cubic centimetres of whole blood was given and here the first peculiar symptoms showed themselves. Immediately after the transfusion the patient had a rise of temperature to 105°, but without chills and without showing blood in his urine the next day. The reaction lasted forty-eight hours following which there was a return to normal. The following week, using another donor, transfusion of 500 cubic centimetres was repeated and again the patient had the same reaction—very high fever without chills and with a negative urine. It is needless to say that meticulous care had been taken to group and cross-group both patient and donor.

On November 13, 1929, splenectomy was performed. On opening the peritoneum, no fluid appeared. The spleen appeared as a greatly enlarged mass, deep red to purplish in color, with numerous rounded protuberances of

varying sizes. It was firm in consistency. There were only a moderate number of adhesions. The weight of the spleen and blood immediately after the operation was 2,600 Gm.

While still on the operating table, immediately post-operative, a transfusion of 500 cubic centimetres of whole blood was given, using one of the same donors from whom blood had been taken before. But now there was absolutely no reaction similar to the previous experiences. In fact, post-operative, the patient never ran a temperature above 100° , and that for only forty-eight hours, when it became normal. One could feel that something had been removed from this patient that had a destructive action on his red blood cells. The general post-operative course was quite uneventful, and within a month the patient was discharged from the hospital.

The organ removed consisted of two separate pieces. (a) A spleen, measuring 30.6 by 14.8 by 6.5 centimetres and weighing 2,020 Gm. It is irregular and very nodular, the nodules varying considerably in size and consistency, some being soft and feeling very cystic, others firm and hard. The spleen tissue itself felt fairly firm in consistence. On section, the organ is quite definitely lobulated, with prominent fibrous strands running throughout the structure. The chief characteristic of the tissue is its spongy appearance, due to the presence of open minute spaces in it. There are some depressed areas, and others slightly raised. The color also varies—many of the nodular areas appearing darker than the surrounding splenic tissue.

Sections of the spleen show microscopically multiple hæmangiomas of different sizes, separated by varying amounts of sclerotic splenic tissue. The tumours are usually poorly demarcated, though some of the smaller growths are circumscribed, but are not encapsulated. The structure consists of dilated, thick-walled sinusoids lined with prominent proliferating endothelial cells and filled either with blood or serum mixed with blood cells, lymphoid cells, desquamated endothelial cells and phagocytic cells containing erythrocytes or blood pigment. These vessels vary widely in size from very small calibre channels to wide irregular spaces often showing papillary ingrowths. The vessel walls contain varying quantities of lymphoid cells, blood and intra- and extracellular blood pigment. The uninvolved splenic tissue shows generalized thickening of the reticulum, with a reduction in the lymphoid cells and atrophy or disappearance of the Malpighian bodies. In localized areas, there is the formation of dense scar tissue. The capsule and trabeculae also show fibrous thickening.

Section of a fragment from the liver shows slight cirrhosis of many of the sinusoids, associated with parenchymatous degeneration or fatty infiltration of the liver cells. The dilated sinusoids are usually free from blood. The capsule of the liver is slightly thickened by fibrosis, and there is slight increase in the interlobular fibrous tissue. Scattered through the fibrous tissue are collections of small round cells.

A follow-up of his blood-picture shows that he has a polycythæmia and that his blood platelets have risen from a pre-operative count of 15,000 to at present 250,000.

Two years post-operative the patient was readmitted to the hospital with a moderate jaundice which was diagnosed as a simple catarrhal jaundice. All examinations for bilirubin were negative.

The two symptoms of which he now complains are (1) impotence, (2) tremor of hands.

This man is well after three and one-half years without evidence of metastases and one may conclude that this was probably in him a benign condition.

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DR WILLIAM CRAWFORD WHITE said that he had looked up the records at Roosevelt Hospital and could not find a single record of such a case. Charles E. Peck reported a case of hæmangioma of the left lobe of the liver about ten years ago which was interesting from the standpoint of the differential diagnosis. The gastro-intestinal series showed the stomach pushed down and the colon pushed down with it. At the time of the operation he was not sure he was dealing with the spleen or the liver.

DR ALLEN O. WHIPPLE asked two questions: (1) whether the blood-vessels in the hilus of the spleen showed marked abnormality and, (2) whether there was present the physical sign of doughiness and pitting at the time of palpation. At the Presbyterian Hospital there have been cases of hæmangioma of the liver in which applied pressure showed a temporary pitting. Doctor Whipple also asked if there were thrills or bruit. These are points described by Alessandri of Rome in hæmangioma of the liver.

DOCTOR PICKHARDT, in closing the discussion, said that to the best of his knowledge there was no elasticity in this particular tumor. It was of great size. There was no bruit and no thrill. He listened for that for he felt there was something peculiar about the mass, but the diagnosis of hæmangioma was not made because this was the first case of hæmangioma of the spleen ever seen in the Lenox Hill Hospital. As far as the blood-vessels were concerned no observation was made at the time of operation, entire attention being concentrated on the problem of getting the spleen out. However, they were not friable and came out without much difficulty. There was no mass of varicose veins.

PLEURO-DIAPHRAGMATIC CYST

DR OTTO C. PICKHARDT presented a woman, fifty-three years of age who was admitted to Lenox Hill Hospital in January 1931. She had been complaining of sharp pain knife-like in character, over the precordium for a period of several weeks. She also described a slight steady pain over the left lower antero-lateral region of the chest. Two years before admission she had been told she had a pleurisy on the left side and she described her recent complaints as being quite like those at the time of her previous illness.

Clinical signs were not definitely diagnostic, chest examination being essentially negative. X-ray examination revealed the presence of a circular shadow just above the left diaphragm. A thorascoscopy with the aid of a Jacobæus thoracoscope was done under local anæsthesia and there could be seen a tangerine-sized, yellowish smooth, glistening tumor mass in the left pleural cavity. Better vision was obtained after the production of an artificial pneumothorax. A second X-ray examination at this time with the lung in a state of collapse showed the spherical mass separated from the heart shadow and lying in intimate relation with the diaphragm.

Thoracotomy was advised and after an interval of several months patient returned to the hospital for this procedure. Under general anæsthesia thoracotomy through the left eighth intercostal space was done.

The two operative procedures were recorded as follows:

(1) In the anterior axillary line of the left side, at the ninth interspace, a small nick is made in the skin and a Jacobæus trocar inserted into the pleural

cavity. Obturator removed and replaced by eye-piece. This eye-piece is gently inserted under direct vision and pushed antero-medially until it reaches the area of the left pleural cavity where the diaphragm, the anterior parietal pleura, the mediastinum and the pericardium meet. Here may be seen a tangerine-sized, yellowish, smooth, slightly lobulated, tumor mass, which glistens. The lung impedes the vision although not attached to the mass and therefore through the seventh interspace a needle is inserted and artificial pneumothorax induced. The globular mass may now be seen to better advantage and is found to have smooth edges, appears to be moderately pedunculated, although the base cannot be seen definitely because of the overhanging edges. Running over the glistening pleural covering are numerous blood-vessels. It does not pulsate within itself but it moves secondarily with spasmodic jerks. In appearance it suggests a lipoma although, as this is the first view of an intrapleural mass with this instrument, only the findings should be described and the diagnosis left for an exploratory thoracotomy which is advised.

(2) An eight-inch incision is made through the left eighth intercostal space with fracture of the eighth and seventh ribs at that angle posteriorly.

The lung appears normal but has pleuritic adhesions posteriorly. The diaphragm is normal in its centre. At the anterior inferior medial aspect, in the costophrenic angle, at the junction of the diaphragm, apex of the pericardium and thoracic cage, there is seen a thin-walled cyst, the size of an orange, with a small, nipple-like projection towards the pericardium. This is covered by diaphragmatic parietal pleura and medially by fat pads from the pericardium. (It was this fatty appearance that gave rise to the possible diagnosis of lipoma at the time of the thoracoscopy several months previous.) Where this cyst lay tightly up against the ribs and costal cartilages anteriorly, a line of cleavage is found with the finger, and the cyst is then easily shelled out, leaving a raw area inferiorly on the muscle of the diaphragm. This area is easily covered by the diaphragmatic pleura which had covered the cyst, the free edge being sutured down by three interrupted plain gut sutures. Very little bleeding occurs, and it is decided not to drain.

The wound is closed, first by approximating the seventh and eighth ribs with several surrounding chromic sutures, and then the muscle layers closed separately with chromic sutures, and finally the skin with interrupted silk. During this procedure the lung is blown up several times so as to touch the chest wall.

The lung and pleura are everywhere normal in color and texture. There is no pleural effusion whatsoever. The portion of the pleura which covers the cyst, and is raised by it, is shiny and normal in appearance. The shelling out of the tumor is easily accomplished.

The pathological diagnosis was pleural cyst, probably of endothelial origin.

The thin-walled cyst was about 8.9 centimetres in diameter, roughly globular in shape. There is a main cystic mass and a smaller one about 1.5 centimetres in diameter. There seems to be no direct connection between the two cavities. There are a number of strands of muscle along one aspect of the main mass.

Microscopical Examination—Section of the small cyst shows a very thin wall composed of dense, laminated fibrous tissue, the greater part of which is acellular or hyaline. The outer part of the wall is looser and rather rich in small cells resembling lymphocytes. The blood-vessels are very scanty. The inner surface is covered with small, deeply staining cells of the type of endothelial cells.

The post-operative course was uneventful, and the patient made an easy recovery, leaving the hospital within three weeks. She had a little temperature for a few days and had possibly more pain for several weeks after the operation than she had had before. Clinically, the application of diathermy gave her the greatest relief, and I believe helped to restoration to normal of the affected area. Follow-up X-rays show that there is now a perfectly normal and clear lung field with possibly a slight hardening of the diaphragm, and the presence of some adhesions in the left costophrenic angle.

The relief from her (pseudo)-pleuritic pains is complete.

METASTATIC OSTEOMYELITIS OF THE CERVICAL VERTEBRÆ

DR OTTO C PICKHARDT presented a man, forty-three years of age, who was admitted to Lenox Hill Hospital in August, 1932, for relief of a painful swelling in the neck and behind the right ear. The swelling had been present for four days, and before admission a small incision had been made, but no relief had been obtained. His previous health had been good and there was no history of an otitis media.

The patient had a temperature of 103.6° and looked acutely ill. There was a brawny induration and redness over the right upper neck region extending over the parotid region and behind the ear. The entire area was tender but no fluctuation could be made out. There was a moderate leucocytosis. X-ray examination of the right mastoid region revealed rarefaction over the knee of the sinus, and there was lack of detail in the tip on the right side as compared with the left.

A mastoidectomy was performed on the day of admission. Except for slight congestion of the mastoid bone, the findings were negative.

On the day after admission a blood culture was positive for *Staphylococcus aureus*. The blood-sugar was 250 milligrams. On the following day, the patient's temperature rose to 106.6° and fell to normal within the next twenty-four hours. For the next two weeks the fever varied from 99° to 103.6° . Repeated blood-cultures during this time were still positive. Leucocytosis persisted with only slight variations. For a time the induration in the neck seemed to extend both anteriorly and posteriorly. Thereafter, there was a gradual decrease in both the amount of tenderness and in the extent of the induration. The mastoid wound healed progressively in about the usual time for such a wound. After the first two weeks, repeated blood-sugars were all within normal limits. Albumen, pus-cells, and occasional red blood-cells were repeatedly found during his four months in the hospital. The Wassermann examination was negative.

In the third week of his illness the patient appeared to be doing quite well, and for the first time the blood culture was found to be sterile. At this time he had a chill and eight hours later complained of severe pain in the back of his neck and in the right shoulder region. There were tenderness and a doughy induration over the posterior cervical region. This was four weeks after admission. An X-ray examination revealed a small, pea-sized area of rarefaction with some thinning of the cortex in the anterior and superior angle of the body of the fourth cervical vertebra. It was considered very suspicious of a suppurative focus. After a two-day interval, there was an apparent breaking through of the cortex of the articular surface of the vertebra. In two weeks' time a still larger area of bone destruction in the anterior and superior angle was found. The patient continued to have a fever of 101° to 102.5° during this time, and the essential treatment was confinement to bed in a plaster shell. X-ray examination six weeks after the onset

GUNSHOT WOUND OF CERVICAL SPINE

of the process in the cervical vertebra revealed a much more extensive destruction with a great deal of bony detritus in the joints between the third and fourth vertebræ, and a reexamination a few days later showed destruction of the inferior articulate surface of the body of the third cervical vertebra with a swelling of the soft part just anterior, suggesting a retropharyngeal abscess. Two weeks later there was very marked involvement in the third cervical body with considerable fragmentation of the bone, and with still greater swelling in the retropharyngeal structures. At this time the retropharyngeal swelling had reached a point where it could easily be felt by the examining finger through the mouth as a hard, indurated, moderately tender mass. The patient was now wearing a reinforced leather collar. This gave a support for his head, and was sufficiently strong so that neither flexion, extension nor rotation of the head and neck was possible. He has worn this to the present time, except lately when in bed.

Röntgen examination in December, 1932, three months after the first X-ray examination, revealed a reparative stage. The detail was much clearer, calcification was taking place, and the bodies of the third and fourth cervicals were regaining their normal contour. The patient was seen at a follow-up clinic several months ago, and his general condition was excellent. The induration in the neck had almost entirely disappeared. X-ray examination at this time did not show any active bone destruction. There was considerable deformity of the fourth cervical vertebra, the body being almost half destroyed. There was, however, no angulation or curvature of the cervical spine. The involved margins of the vertebræ were sharply outlined, indicating excellent healing. X-ray examination during the present month demonstrated osteogenesis, and no active recognizable bone destruction was present.

DR ROBERT H. KENNEDY said that reviews of a large series of cases of osteomyelitis showed that lesions of the vertebræ comprised less than 15 per cent of these. The occurrence is probably much more common than the statistics show because of the difficulty in diagnosis. It is more rare in the cervical than in the lumbar or dorsal regions. Moreover, one would not expect this lesion in a man of this age as it usually occurs before the age of twenty. Considering the excellent result in this case, the usual mortality is interesting. It averages 60 per cent in osteomyelitis of the vertebræ in general and about 30 per cent in the cervical region, according to the statistics of large groups of cases. It is probable that infection of the bone was present at the time of admission, for one would expect a period of at least two or three weeks to elapse before the X-ray findings would be so definite. Doctor Kennedy said that he did not think he would have refrained from operating because of apprehension lest the pus extend downward behind the pre-vertebral fascia into the mediastinum. The retropharyngeal abscess could have been drained through a lateral incision in the neck. However, the result could not have been better than that shown in this patient.

GUNSHOT WOUND OF CERVICAL SPINE

DR JOHN J. MOORHEAD presented a man sixty years of age who was admitted to the Post Graduate Hospital February 8, 1933. On the day of admission in a hold-up he was shot at very close range with a 38-calibre revolver. The wound of entrance was in the left supraclavicular region one

inch internal to the outer end of the clavicle and about three-fourths inch above it. The left cheek and left side of the neck showed powder marks and there was swelling and ecchymosis on the left side of the neck and considerable swelling of the left upper extremity. He was able to elevate the arm to about half a right angle. There was no apparent neural damage except for a complete loss of sensory distribution on the hand corresponding to the ulnar distribution. The left-sided Horner's syndrome was established by Doctor Sherwood, the neurologist, who saw him in consultation.

The X-ray examination showed the pointed end of the bullet lodged in the interspace between the lateral border of the seventh cervical and first dorsal vertebra and apparently it had entered this space forcibly enough to spread the vertebral bodies apart. Twenty-four hours later, under general anaesthesia, the wound of entrance was debrided, finger palpation located the bullet, a counter opening was made and through this a clamp was introduced as a guide and the entire tract was laid open. Small fragments of bone were removed first and then with a strong clamp the bullet was grasped and removed. Also soft part debris was removed and the tract was lavaged with ether and partly sewed. Vaseline gauze drain and heavy dressings. Convalescence was uneventful except for the development of a very curious pallor and coldness affecting the right hand and the right forearm which developed the day after operation and persisted in diminishing degree for about a week, but was unaccompanied by any motor or sensory loss. There was considerable swelling of the left upper extremity but this gradually decreased and at this time with the aid of physiotherapy it has largely disappeared. The neck motions are free and the involvement of the ulnar nerve is much less.

DR BYRON STOOKEY said that since the War no one is amazed at what a bullet may do. In fact, the unexpected may prove to be the expected. In this particular case the fact that the bullet stopped immediately at the intervertebral foramen is of only passing interest. Doctor Moorhead stated that the patient had a paralysis of the ulnar nerve and Horner's syndrome, by that he means an injury to the component roots which make up the ulnar nerve, namely, the eighth cervical and the first thoracic. Watching the patient one would gather that he is unable to extend his wrist and it is probable that the seventh cervical root is injured as well. Exploration of the damage done to the nerve roots by a collar incision would have been advisable had this been possible since early suture of the nerves before scar tissue is formed makes for a better end-result and certainly much simpler operation.

FRACTURE DISLOCATION OF CERVICAL SPINE

DR JOHN J. MOORHEAD presented a seventeen-year-old boy who was admitted to the Staten Island Hospital November 22, 1930, in the service of Doctor Driscoll with a history of having sustained a fracture dislocation of the fifth cervical vertebra on the day of admission in a football game. He was not unconscious, when carried off the field he was unable to use his arms but their function was regained en route to the hospital and on arrival in the institution it was noted that there was free movement of the arms and legs. The first X-rays taken by Doctor MacBrayer disclosed a very extensive fracture dislocation at the fifth cervical level. He was immediately placed in traction

FRACTURE DISLOCATION OF CERVICAL SPINE

and during the ensuing two days motor and sensory involvement appeared in both arms, being more marked on the right

On the night of the twenty-fourth an attempt was made to reduce the dislocation manually but this did not succeed and thereafter the repositor was applied under fluoroscopical control. It was felt a definite gain had been made and this was verified by subsequent X-rays. However, on the twenty-eighth it was noted that there was apparently a total paralysis of the right arm and both legs and an incomplete paralysis of the left arm so that the forearm could only be flexed weakly. The arms and legs were flaccid and there were no abdominal or cremasteric reflexes. Doctor Masson, the consulting neurologist, stated that the cord condition was very much worse than before the attempts at reduction.

On the twenty-ninth a laminectomy was done with the removal of two spinal processes and it was then seen that the cord was sharply angulated and that there was considerable oedema and that a locking of the articular processes had prevented complete reduction. At the operation no attempt was made to unlock these because the laminectomy apparently provided ample decompression. Five days later improvement was noted in the left upper extremity there was no power in the legs or in the right upper extremity and pain and temperature was lost on the trunk and thighs and in addition there was a left-sided Horner's syndrome. A plaster-of-Paris neck and body case had been applied and eleven days after laminectomy considerable improvement was noted particularly of the lower extremity and in the left arm and finger motions were noted on the right hand noted marked improvement.

December 30, three weeks after the operation, there was still further improvement. The worst remaining symptom was an atrophy of the intrinsic muscles of both hands.

He was removed to the Post Graduate Hospital January 6, 1931, and discharged February 24, 1931. The original plaster dressing was removed December 15. Primary union had been obtained and thereafter he wore a metal head and neck support for many months. February 3, 1931, another repositor reduction was attempted but without changing the bony contour, but with rather striking improvement as to the arms. His improvement was continuous and prior to the time of his discharge from the Post Graduate Hospital, namely, three months after the injury, he was able to walk about the ward with considerable ease and had excellent motion of both lower extremities with little if any sensory involvement therein, and likewise there was considerable improvement of the right upper extremity, but there was still considerable loss of power in the left with some sensory disturbance.

He has been seen at intervals since and at this time, approximately three and one-half years after injury, function is practically normal in all the extremities except for some lessened muscle power in the left upper extremity when unusual use is made of this extremity.

DOCTOR STOOKEY said that dislocations of the cervical vertebræ if seen early should be reduced early and that as little time as possible should be allowed to elapse before reduction. Of all methods available the method devised by Alfred S. Taylor is by far the best. By use of the Taylor method he has not experienced any great difficulty in reducing cervical dislocations when they have been seen early. On the other hand when seen late reduction may be impossible by any method due to contracture and shortening. Reduction by traction with the hands is seldom successful due to the fact that sufficient traction cannot be exerted in this manner. In Taylor's method of re-

duction is used a chin and occiput strap made of molokskin adhesive, the ends of which are tied to a rope which is passed around the hips, the hips being protected by a pillow, or folded blanket. Thus, the trunk musculature can be used and sustained and steady traction exerted, leaving the hands free to guide the vertebrae and manipulate them so as to obtain reduction. Locking of the articular processes can be overcome if adequate traction is applied. In Doctor Stookey's opinion this can be done only by a method which exerts steady, continuous traction and not if the traction is alternately exerted and relaxed. In early cervical dislocations successful reduction will result if this method is followed.

KNEE ARTHROTOMIES

DR JOHN J. MOORHEAD presented a man, March 3, 1928, from whose right knee-joint eight ounces of clear yellow fluid were aspirated, the history being that there had been a progressive painless swelling in that joint without known cause for two years. Examination at that time disclosed evidence of a hypertrophic synovitis without any corroborating signs of semilunar cartilage or of any other joint calculus involvement. X-rays were negative. The fluid recurred and April 9, 1928, through a mediolateral incision, an arthrotomy was done on this knee at which time a moderately complete synovectomy was performed together with the removal of some hypertrophied fat pads and an eroded internal semilunar. The convalescence was uneventful and he had no difficulty with this joint for about a year. On March 7, 1929, an aspiration of the same joint for a recurrence of symptoms yielded approximately fifty cubic centimetres of clear yellow fluid. On both occasions this fluid was negative to culture.

April 8, 1929, another synovectomy was done on this knee-joint through an identical incision and at the same time the external semilunar cartilage was removed because it also was eroded. A pathological examination of the removed material in each instance showed evidence of chronic inflammation. This right knee has remained well to date, namely, for four years.

December 4, 1930, the left knee was operated upon for a condition practically identical with that originally encountered on the opposite side and at this arthrotomy a very extensive synovectomy was performed, together with the removal of excessively large fat pads and an eroded internal semilunar. There was a recurrence of the painless swelling in this left knee after approximately two years and under date of November 17, 1932, another arthrotomy of this left knee was performed and at this time great masses of hypertrophied synovial lining were excised together with the external semilunar. This knee has remained well until about six weeks ago and he now tells me that it is beginning to swell and examination (eight days ago) verifies this, but as can be seen there is not swelling enough to warrant interference.

Here is a case of bilateral hypertrophic synovitis without bone involvement in which, during a period of five years, the right knee has been aspirated twice and two extensive arthrotomies have been performed and the left knee has also undergone a similar sort of exploration minus the aspiration. The notable features are that no known focus has been ascertained although diligent search has been made. The culture of the fluid and the removed synovial lining remained sterile. All serological tests remained negative. These knees demonstrate the reformation of their lining and also demonstrate that the

RELATIONSHIP OF THYROID DISEASE AND PANCREATIC FUNCTION

very extensive removal of intrinsic structures does not interfere with function. These arthrotomies were performed by the technic presented before this society January 27, 1932.

EXPERIMENTAL AND CLINICAL STUDIES OF THE RELATIONSHIP OF THYROID DISEASE AND PANCREATIC FUNCTION

DR J WILLIAM HINTON read a paper with the above title and presented six patients to illustrate his paper.

CASE I—Female, aged twenty-eight years, was first seen August 27, 1931. Chief complaint was nausea and vomiting, with pain in epigastrium for the past ten years, which was generally worse around 10 or 11 o'clock at night, or when she was unduly tired. In 1920, she was having abdominal discomfort and had X-rays taken in the Boston City Hospital. The X-rays were reported suspicious of an ulcer, although a positive diagnosis was not made. She had had two gastro-intestinal X-ray series done in August of 1931, the first revealing a slight tenderness over the duodenum and suggestive of a filling defect but repeated studies two days later did not reveal any organic lesions of the stomach or duodenum. There was persistent abdominal pain. Physical examination did not reveal any epigastric tenderness but her skin was dry, pulse 64 and the patient's hair was very thin and she complained of it falling out. Her finger nails were brittle, skin chapped easily and she complained of tiring very easily. She frequently vomited undigested food. A diagnosis of hypothyroidism was made and a basal metabolism done on August 28, 1931, revealed a minus 18. Patient was put on thyroxine one milligram, intravenously, and thyroid extract gr 1, T I D. This was continued at weekly intervals until November 11, 1931, when a basal metabolism was a minus 8, at which time she was still having some abdominal discomfort but greatly improved. She was seen again November 17 and 27, and was not seen again until January 30, 1932. At that time she stated she was feeling very well and only slightly nauseated, her hair was greatly improved, and she was encouraged. Basal metabolism at this time was a plus 3 and she was taking thyroid extract gr 4, T I D, which she had been taking since her last visit in November. Patient was seen about every six weeks from January to July, and on July 22 she was complaining of being tired and having slight abdominal pain, although her weight was ten pounds over what it had been when she was first treated. Basal metabolism repeated on July 27, 1932, was a minus 14. The patient was then seen at weekly intervals and given one milligram of thyroxine, and thyroid extract gr 6, T I D, for a six-week period, and her symptoms entirely disappeared and she has had no complaints referable to her stomach condition since. On January 4, 1933, her basal metabolism was a plus 3, and she had no complaints. The patient was taking thyroid extract gr 2, B I D. When last seen on March 15, 1933, she was feeling very well and symptom-free. This patient has to continue taking thyroid and thyroxine at fairly regular intervals or her basal metabolism will drop and her abdominal symptoms will return.

CASE II—Male, twenty-nine years of age, seen June 4, 1932, complaining of upper abdominal pain which comes on one or two hours before meals and usually is relieved by the intake of food. He had been under the care of several physicians. X-rays revealed a duodenal ulcer, for which he had been treated. Five years previously he had had an appendectomy for chronic appendicitis but following the operation he continued to have the same discomfort as previous to the appendectomy. At the time he consulted me he stated the pain was through the upper portion of the abdomen, radiating directly through to the back, and was more annoying than the abdominal pain. Examination revealed definite tenderness in midepigastrium. A diagnosis of duodenal ulcer had been made, and he was referred to the reporter for operation. Operation was postponed and further medical treatment continued, which was persevered in for five months, but failed to make any satisfactory progress. All previous medication was then discontinued and he was

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placed on thyroxine one milligram intravenously, and thyroid extract gr 1, B I D. This was continued at weekly intervals for the next four weeks. October 25, X-rays were negative for a duodenal ulcer. He continued to make weekly visits until December 13, at which time he was practically free from symptoms and was feeling better than at any time since under treatment. He was next seen on December 27, January 24 and March 7 of 1933, and was feeling very well but was continuing thyroid extract grs 1, B I D, by mouth, and had gone from November 1 to March 7 with practically no discomfort whatsoever.

This is the first patient with an ulcer that was given thyroxine and thyroid medication. At a meeting of the New York Surgical Society on October 12, 1932, cases of abdominal pain with hypothyroidism were presented and Doctor Sweet suggested that patients with ulcers be treated with thyroxine and thyroid extract to see what effect it might have, and in view of the fact this patient had been put on treatment only two weeks before the meeting it gave him encouragement to treat a number of other ulcer cases that had not been on other medications.

CASE III—A man, aged thirty-eight years, was admitted to the Gastro-Enterological Clinic of the Fourth Medical and Surgical Divisions of Bellevue Hospital, November 17, 1932, complaining of pain in his abdomen with nausea and vomiting for the past seven or eight years. He had periodicity of pain and at times the pain radiated to his back. During a recent attack he had lost ten pounds in weight and vomited daily. The patient had known for three years that he had a duodenal ulcer as X-rays taken at that time revealed a positive ulcer. X-rays presented at the time of his first visit, taken October 27, 1932, revealed a persistent defective filling in the inner and outer borders of the duodenum. There was also a defective filling in the pre-pyloric region of the stomach, and a diagnosis of duodenal ulcer was made with no six hour retention. Physical examination was negative and the patient was placed on a fourth-week Sippy diet and given 1 milligram of thyroxine and thyroid extract gr 1, T I D. He was seen at weekly intervals and thyroxine administered. On December 15 the patient stated he had a severe cold but no abdominal pain. Weight at that time was 175 pounds. From that period to the present date the patient has had no abdominal symptoms. He has been seen regularly every week and the thyroxine and thyroid medication continued. Basal metabolism done March 22 was a plus 11. X-rays taken on March 27, 1933 revealed an ulcer of the first portion of the duodenum but no six-hour retention. On March 30, 1933, patient weighed 196 pounds, which was the most he ever weighed, and twenty pounds over what he weighed when he entered the clinic.

CASE IV—Male, thirty-eight years of age, admitted to the Gastro-Enterological Clinic of the Fourth Medical and Surgical Division, Bellevue Hospital, November 17, 1932, complaining of pain in upper abdomen for a period of two to three years, which comes on for a period of a month or two and then gradually subsides, without nausea or vomiting. He never knew what the trouble was until just before entering the clinic when X-rays were taken which revealed an ulcer of the first portion of the duodenum with no six-hour retention. Patient was put on a fourth-week Sippy diet and thyroxine 1 milligram intravenously, and thyroid extract gr 1, T I D. On December 8 his only complaint was constipation but no abdominal pain. Since December 15 he has had no complaints and now is symptom-free. He has been seen weekly and thyroxine administered intravenously, as well as continuing thyroid extract by mouth.

CASE V—Male, aged sixty years, admitted to the Gastro-Enterological Clinic of the Fourth Medical and Surgical Division of Bellevue Hospital on December 15, 1932, stating that five years ago he had gas and pain in the pit of his stomach and one month later he went to the Kings County Hospital where X-rays were taken and he was put on a Sippy diet for two weeks. He was told he had an ulcer of his stomach and advised immediate operation which he refused. He left the hospital and has not been under a doctors' care since but has watched his diet quite carefully and has been practically free from symptoms until six weeks ago when his original discomfort returned and now he has gas and pain in

RELATIONSHIP OF THYROID DISEASE AND PANCREATIC FUNCTION

his stomach Examination reveals tenderness in epigastrium but no masses felt X-rays taken December 14, 1932, revealed the presence of an ulcer of the lesser curvature at the pars pyloric and media The patient was put on a fourth-week Sippy diet, thyroxine 1 milligram, intravenously, and thyroid extract gr 1, T I D He was seen at weekly intervals and on December 29 he still complained of pain but was taking the thyroxine and thyroid extract On January 5 he felt very well and had no complaints Since that time he has been seen weekly, and thyroxine continued, and thyroid extract taken regularly by mouth, he has been symptom-free and was last seen April 6, 1933 X-rays taken February 27, 1933, revealed no organic lesions of the stomach or duodenum Fluoroscopic examination revealed slight rigidity at the site of the ulcer which is now completely healed Basal metabolism done February 17, 1933, was a minus 4

CASE VI—Female, age thirty-one years, admitted to the Gastro-Enterological Clinic of the Fourth Medical and Surgical Divisions of Bellevue Hospital on November 3, 1932, complaining of having had pain in epigastrium for the past year, with no vomiting but occasional nausea and constipation X-rays taken October 28, 1932, revealed a pyloro-duodenal spasm with 30 per cent gastric residue at the end of six hours Patient was placed on thyroxine 1 milligram, intravenously, and thyroid emblems gr 1, T I D but she did not return to the clinic and a home follow-up on January 30, 1933, revealed the patient continuing to have her abdominal pain and she was very much discouraged She returned to the clinic on February 3, 1933, and was placed on thyroxine 1 milligram, intravenously, and thyroid extract and has been seen at weekly intervals since that time On March 9, 1933, she was feeling well, without complaints, and when last seen on April 6, she was symptom-free but continued to take thyroxine and thyroid extract Her basal metabolism done on March 24 was a plus 12 and her gastro-intestinal X-ray series April 5 revealed a duodenal ulcer, but no six-hour gastric residue

DR PAUL C MORTON (by invitation) pointed out that the relationship of the histological picture to the chemical determinations of iodine in the gland were at variance with the usual and accepted picture The general conception of this subject is that the iodine in the thyroid gland is in direct proportion to the amount of stainable colloid present With this in mind, in looking over the sections, it was rather surprising to find that the amount of iodine in the gland did not apparently correlate itself with the amount of stainable colloid along the lines of this premise A gland with a high iodine content would show very little if any increase in colloid in the sections It was especially stressed that the observations on the clinical course of these animal experiments seemed to be of more value than the histological picture of the various organs examined

It is impossible at this time to explain this variance between iodine content and colloid as stated above On the other hand, in doing these experiments, certain very definite things were noted in the animals

(1) When the pancreatic duct was tied and sectioned, these dogs developed colloid goitres

(2) When they were fed potassium iodide with the ducts tied, they died within a very short time

(3) When these animals were given thyroxin after the duct had been tied, they could be carried along in normal health for a considerable length of time

It is hoped that this type of clinical observation together with the chemis-

tion of tissues will lead to a better understanding of the problem than histological studies

In all of these animals the adrenal glands were removed at autopsy and histological slides made. Tyrosine is the amino-acid from which both epinephrine and thyroxin are apparently made by the body. This close chemical relationship between these two secretions would make one consider that possibly the adrenal glands might show some disturbance along with the thyroid if the original assumption as presented by Dr. John Sturge Davis is correct. Preliminary studies of these adrenal glands would indicate that there are abnormal changes in some of the sections. This will bear further study.

The speaker further emphasized that this work is based upon experimentation involving some sixty-five animals to date, and that this is a new approach to the question of diseases of the thyroid.

DR. CARNES WILKS said that he thought one of the most important things Doctor Hinton has shown here tonight is the extreme variation in the histological picture of the so-called normal thyroid. As this varied picture is true of the human thyroid so is it true of the dog, and it is easy to see how careful one must be in interpreting the histological findings of experimental work done on the thyroids of dogs. It has been suggested to us that we give all our dogs iodine before any experimental work is done in order that their thyroids may show approximately the same picture. Obviously this would not have been possible in most of the work that Doctor Hinton has reported. In the small number of normal human glands which have been examined for total iodine content there has been as marked a variation as in their histological picture, the figures ranging from 50 to 200 milligrams of iodine per 100 grams of dried gland. The estimation of iodine content in conjunction with a study of the histological picture is being continued in these normal glands in hopes of obtaining some significant relationship.

DR. JOSHUA E. SWIFT said that thyroid researches had been almost exclusively concerned with the study of iodine. This work has shown that the iodine in the thyroid is in combination with some protein derivative but very little attention has been paid to this protein factor. The chances are certainly even that the trouble may lie in the protein fraction rather than in the iodine fraction, in fact certain studies have shown that substitution compounds, in which the iodine was replaced by another halogen, such as bromine, exhibit the same action as thyroxin. The whole problem of the thyroid is of interest and filled with inescapable contradictions. No operation in surgery results in such satisfaction to both patient and surgeon and yet there is no operation so illogical. The authors of this paper are to be congratulated upon their effort to approach the problem by a new route.

DR. WILLIAM BARCLAY PARSONS said that in little ways here and there we have amassed information and knowledge about the various glands of internal secretion. Hypo- and hyperthyroidism, hypo- and hyperparathyroid-

ism, hypo- and hyperinsulism are now readily recognized and may be treated with considerable success. The cross-relationship of the various glands is still obscure, and any studies along this line are most worth while. The speaker, however, could not follow Doctor Hinton's logic in reference to the accumulation of colloid in the experimental animals with the pancreatic ducts ligated. It is generally admitted that colloid consists largely of thyroglobulin, an iodine-containing substance in which the iodine occurs either in thyroxine or in diiodotyrosine, and unless the animal has been receiving large amounts of inorganic iodine for several days immediately preceding death, there will not be more than a trace of uncombined iodine in the glands. If tyrosine absorbed from the intestinal tract is the source from which diiodotyrosine or thyroxine is produced, how can the gland increase its colloid content if tying the pancreatic ducts eliminates the possibility of the formation of tyrosine in the intestinal tract?

Doctor Parsons also could not understand the rapid deaths of the animals receiving potassium iodide following tying of the ducts, but the picture produced by the exhibition of tyramine suggests the findings reported by Cole and Womack in animals killed by infection or different chemical poisons. Whether or not some such circumstance has obtained in the animals reported tonight is worthy of thought.

In his paper Doctor Hinton spoke about the poor results in the use of thyroid extract alone in hypothyroid patients, and the necessity for the use of thyroxine in most of these patients. This is expensive and a nuisance to the patients, and very seldom results in a really satisfactory result. This is one of the main points in being somewhat conservative in the amount of tissue left behind after operation, and is why the speaker disagrees with those writers who have the production of hypothyroidism as their object in operating for hyperthyroidism.

DR ARTHUR S. MCQUILLAN noted the fact that Doctor Hinton extirpated one lobe of the thyroid in all the dogs used in this series. This was done for purpose of control of the iodine content of the dog's normal thyroid tissue, and some time before the ligation of the pancreatic ducts. Doctor McQuillan emphasized the fact that extirpation of one lobe of a dog's thyroid gland resulted in the hypertrophy of the remaining lobe and an increase of iodine content up to 30 per cent. The fact has been well established in a series of experiments done by Dr. John Rogers at Cornell in 1921 to show the effect of iodine content of a dog's thyroid gland as a result of adrenal feeding. The increased iodine content was noted in the controls. Doctor McQuillan felt that Doctor Hinton's work should have had this control so as not to include this fact in the results of his work.

DR EMIL GOETSCH pointed out that too much cannot be concluded from the mere appearance of the thyroid gland at any particular moment. Thus, in spite of the fact that the thyroid may contain a large amount of colloid, it may still be functionally rather active and the reverse may also hold. It is

essential that one determine the function of the thyroid cells themselves regardless of the amount of colloid present. He has been interested for a number of years in this problem and has been able to show that the best criterion of cellular activity that we know of at the present is the cellular content of mitochondria. An abundance of these intracellular structures indicates activity. A small part or relative absence indicates inactivity. He asked Doctor Hinton whether the dogs that were submitted to autopsy were sacrificed or whether they had died in the course of the experiment and were then examined. The reason for this question was that the thyroid, being exquisitely sensitive to any changes within the organism, would respond to the profound changes which occur during the latter days of any experiment in which the animal is allowed to die of natural causes. Thus one factor might be that of starvation, for the dogs as is well known will stop eating sometimes for several days before they actually die as a result of the experiment. This starvation alone has a profound effect upon the appearance of the thyroid as was shown some years ago by Jackson of the University of Minnesota.

DOCTOR HINTON in closing the discussion, replied to Doctor Parsons that there is considerable debate among investigators as to how the iodine is stored in the thyroid gland. It is maintained by some authorities that iodine is in the form of thyroxine, or a composition that is physiologically equivalent to thyroxine. Others maintain that 50 per cent of the iodine is in the form of diiodotyrosine. The question of tyrosine and how it works was the basis of this study. If thyroxine is formed from tyrosine and the protein metabolism is interfered with and by so doing eliminates the supply of tyrosine to circulate in the thyroid gland, then the iodine content of the gland is increased, due to the fact that the iodine cannot combine with tyrosine to form diiodotyrosine that finally changes to thyroxine which is the active principle of the gland.

Urinary diastase was not done on these patients but the amylase and lipase of the blood were determined in both dogs and humans. The dogs had their pancreatic ducts ligated, but no increase was found in either of these constituents in the blood. In humans, suffering from ulcers with a history of chronic pancreatitis, it was not possible to determine an increase in either amylase or lipase of the blood. Twenty-five determinations were done on human subjects, and fifteen dogs were used with repeated blood examinations.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD MAY 12, 1933

DR RODERICK V GRACE, in the Chair

ANEURISM OF EXTERNAL JUGULAR VEIN

DR ARTHUR S McQUILLAN presented a woman, fifty-three years old, who was admitted to the Misericordia Hospital June 1, 1932, complaining of a swelling in the supraclavicular region. This swelling was first noticed about six years previous as a sequel to taking an anæsthetic for an operation about the mouth. At this time she was given gas-oxygen anæsthesia, and there was considerable difficulty and struggle in going under the anæsthetic. It was during this induction of the anæsthetic that she felt something snap in the right supraclavicular region and for several days after the operation there was a soreness and lameness in this region. About four months later there appeared a swelling in this area which has always been soft and movable and has never given trouble until about three weeks before entering the hospital. At this time the lump became larger, very tense and hard.

When admitted examination showed a spherical swelling about two inches in diameter in the right supraclavicular region about one inch in diameter above the clavicle in the line of the external jugular vein. To palpation the swelling was tense, indurated and fixed to surrounding structures. There were no pulsations, thrills, or bruit. There were no other nodules found in the cervical region on either side.

At operation this mass was freed from surrounding tissue, the mass being surrounded by a capsule that resembled in color and structure the wall of a vein. Adhesions were thin and newly formed, making enucleation easy. It was found that the external jugular vein above and below led into this mass. For this reason the mass with a section of vein about one inch long above and below it was removed, the proximal and distal ends of the external

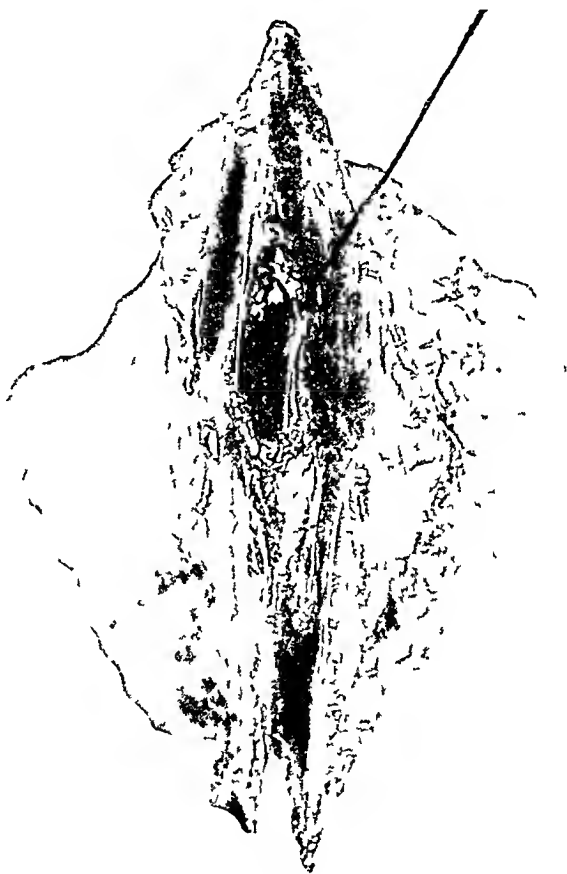


FIG 1.—Opening from vein into aneurismal sac

jugular being ligated. On opening the vein wall it was found that the mass was connected with the vein by a small opening about one-eighth of an inch in diameter through which opening particles of clotted blood could be squeezed, and making it apparent that this small opening led from the lumen of the vein into a true aneurismal sac (Fig 1)

DR JOHN H MORRIS stated that he had been unable to find a report of any similar case in the literature. There were one or two points about it to be considered. First, was the term aneurism correct and, second, if so, did this case fulfill the general conception of an aneurism? It is a fact that one gets the impression from the classification of aneurism that this term should be restricted to arteries. There is, however, no logical reason for this viewpoint since arteries are similar to veins anatomically as well as embryologically. As regards the second point, Keene has defined aneurism as a hollow tumor filled with blood communicating directly with the parent vessel and developed in whole or in part at the expense of its walls. This case evidently fulfills both of these requirements. As regards the classification, many types of aneurisms are mentioned but two only may be considered as pertinent to this case. One is the pathological type of aneurism in which the media is affected by a disease process commonly arteriosclerosis. As a result stretching or rupture of the middle coat follows with the production of the aneurismal pouch. The other type is the traumatic. This may be due to a perforating wound of any type, that is, a direct trauma, and in deference to this case one might take into consideration indirect trauma as the cause where, due to the patient's struggles under general anaesthesia, sudden violent increase in intravenous pressure occurs. Most authorities agree that the essential histological feature common to all true aneurisms is the absence of media from the coverings of the sac. Therefore, the pathogenesis of such aneurisms must be referred to whatever cause is producing a breakdown of the media. One is a toxic or bacterial invasion, syphilis has been given as a cause. Another is the arteriosclerotic process. Still another is mechanical and is produced by sudden increase of intravascular pressure. Experiments have shown that rupture of the media of a normal vessel does not occur from any pressure that could develop under living conditions in man. Where pathological changes have occurred in the media, however, even moderate degrees of pressure are found to be capable of producing stretching or rupture of the middle coat. Therefore, if one assumes that the rupture of this vessel occurred as a result of indirect trauma, there must be assumed some predisposing pathological change in the wall of the vein.

In the study of vascular disease, attention has been largely centered on the arteries, but recently it has been shown that phlebo- or venosclerosis is a relatively common condition which is analogous to similar processes occurring in arteries. Therefore as regards this case it seems permissible to assume, first, that this is a true aneurism of the external jugular vein, and, second, that it was induced by sudden violent increase in intravenous pressure in a vein which was the seat of some neural degenerative process.

PARATHYROID TUMOR

PARATHYROID TUMOR

DR McQUILLAN presented a woman, forty-six years old, who was admitted to Bellevue Hospital October 28, 1932. Her chief complaint was a swelling on the outer aspect of the neck. Family history was negative as far as goitre was concerned. Present history dated back twelve years when she noted difficulty in swallowing following childbirth. Five years later she noticed in the right side of her neck a swelling which has gradually increased in size to the present time. It has been noticed that this swelling has increased in size during menstrual periods. There is at present no tachycardia, no difficulty in swallowing, no nervousness or tremor. She has taken iodine off and on for the past year. B. M. rate within normal limits. Menstrual history, negative. Has had nine children, seven of whom are living. She was a well-nourished woman. In the region of the right lobe of the thyroid there was a swelling about the size of an orange, somewhat nodular moving with swallowing. A high-pitched bruit could be heard on the upper surface of the neck. No tremors.

Four days following admission this tumor was removed. The whole right lobe of the thyroid was found involved by a degenerated nodular mass. There were many large veins covering the surface of the tumor. The left lobe of the thyroid was found to be normal. The wound healed by primary union and the patient was discharged from the hospital nine days later. The pathological report on section of this tissue was, parathyroid adenoma, composed entirely of oxyphil cells. There was a thin transparent capsule, the underlying tissue having a pink color. There were many prominent veins. On section the surface was smooth and homogeneous with a pink color.

She was later readmitted to the hospital where an X-ray of the bones of the skeleton was found to be normal. Blood calcium determination of 10.2 and blood phosphate determination of 4.2 were within normal limits.

DR RUSSEL H. PATTERSON stated that Doctor McQuillan's case was a relatively rare one. One of the first cases of hyperparathyroidism reported in this country was that of Dr. Eugene DuBois. The patient had been operated upon twice in Boston and no parathyroid tumor was found. Doctor Patterson operated again on the patient at Bellevue Hospital and no parathyroid tumor was found. After one more operation in Boston another search (the fifth) was again performed and a parathyroid tumor was found in the mediastinum. Doctor McCallum of Baltimore charted the parathyroid glands in sixty-seven autopsied cases. If there were four parathyroid glands in each case Doctor McCallum charted the location of 268 parathyroids, 267 of these parathyroids were located in the usual position, *i. e.*, on the posterior of the thyroid gland. One gland was found to be in the mediastinum. Thus the chances are one in 268 that a parathyroid tumor may lie in the mediastinum. Another interesting point of Doctor DuBois' case was the rapidity in which a fracture would heal. In one instance the patient sustained a fracture of the surgical neck of the left humerus. Solid bony union was present eighteen days after this fracture.

Doctor McQuillan's case was unique in that the patient had a parathyroid tumor without the serum calcium and phosphorus changes and the balance of the clinical syndrome which usually goes with a case of parathyroid tumor.

It is certainly true that decalcification of the skeleton, a negative calcium balance, a high serum calcium and a low serum phosphorus always means a tumor of the parathyroid gland, but, if one may judge by Doctor McQuillan's case, the converse is not true. Doctor Patterson emphasized, in closing his remarks, that there seemed to be no justification for removing the parathyroid glands in Paget's disease or polyarthritis.

DOCTOR MCQUILLAN rejoined that Da Costa in 1908 reported a case very similar to this one both in regard to blood and bone changes and size of tumor. Turnbull and Hunter in the British Journal of Surgery, October, 1931, reported a series of thirty or forty cases, and Barr (published in the Journal of the American Medical Association about 1920) also reported a series. The tumors in the majority of these cases were all small, on the average of two by four centimetres in diameter. It is only in one or two that the tumor was reported to be as large a one as in the case now presented. There were only a few cases reported which were described as being made up of wholly oxyphil cells or having the majority of cells of the oxyphil type. There were many described as having the majority made up of the chief or principal cells, and, also, some cases were reported where both cells were in abundance. The majority of the cases also showed calcium and phosphorus changes in the blood as well as bone changes and only a few parathyroid tumors were similar to the one presented showing no blood or bone changes.

VOLVULUS OF THE SMALL INTESTINE DUE TO INCOMPLETE ROTATION IN AN INFANT TWELVE DAYS OLD

DR EDWARD J. DONOVAN presented a female child, now one and a half years old, who was admitted to the Babies Hospital October 31, 1931, at age of twelve days. Normal delivery at term. Baby has vomited practically everything since birth. Was breast-fed for four days, but the breast was discontinued because of the vomiting. Various formulæ with or without atropine were tried, but the baby always vomited immediately or from one to two hours after each feeding. Vomitus was often bile-stained. It was not projectile, and it contained no blood at any time. Four days before admission she was X-rayed at a private sanitarium where diagnosis of pylorospasm was made. Bowels had moved daily, stools were always constipated and of green color.

Upon admission she was very dehydrated, showed a marked loss of weight, was limp and weak. Physical examination was otherwise negative. She was given an immediate glucose infusion and improved so much by it that in a few hours it was possible to give her a little barium for fluoroscopy. Under the fluoroscope, the barium was seen to pass to the third part of the duodenum, reverse its direction and pass back into the stomach. At the end of five hours, no barium had passed the third part of the duodenum. Weight at time of operation, four and a half pounds. She was operated upon immediately and a volvulus of the entire small intestine from the duodeno-jejunal junction to the ileocecal junction was found. This intestine was turned in a clockwise direction four complete turns around the superior mesenteric artery and the root of the mesentery as an axis. The intestine

CHOLECYST-GASTROSTOMY IN AN INFANT THREE MONTHS OLD

was completely collapsed and blue, but the volvulus was easily reduced by turning it in a counter-clockwise direction four full turns. Color of the intestine improved immediately. No part of the large intestine was involved in this volvulus. The cæcum and appendix lay in the left upper quadrant. The gastrocolic omentum and transverse mesocolon had not fused. The cæcum was brought down to the right lower quadrant and sutured to the posterior parietal peritoneum. Convalescence was uneventful, and it is now one and a half years since operation. The child is entirely free from digestive disturbances and is developing normally.

The condition at fault in this case was that the ascending colon had not come down to the right lower quadrant and fused to the posterior parietal peritoneum, which is the last step in rotation of the intestinal tract after it has returned from the extra-abdominal sac where a great part of its development takes place. The speaker said that he had operated upon two other cases of this condition at the Babies Hospital. They were aged ten and twelve days, respectively. The findings in all three cases were identical, that is, cæcum and ascending colon in the left upper quadrant, failure of the gastrocolic omentum and transverse mesocolon to fuse, failure of the ascending colon to attach itself to the posterior parietal peritoneum in the right lower quadrant of the abdomen.

DR CHARLES E FARR said that he had operated upon a number of these anomalies with lack of descent and rotation of the cæcum. He had had no case exactly similar to Doctor Donovan's, that is, acute volvulus at the time of operation, but several gave symptoms of partial volvulus and showed some evidence of it at the operation. None was a young infant. The worst case he ever saw was a man of seventy-four years who was operated upon for a carcinoma of the stomach. Here there was complete lack of descent and rotation, the duodenum lay in front of the transverse colon and the jejunum was all tangled up in a mass below the colon and to the left. This man had been perfectly well all his life until the advent of his carcinoma.

Another similar case, in a child one year of age, showed an almost complete obstruction of the jejunum as well as a complete absence of descent and rotation. This child was cured by untangling the bowel and suturing the cæcum and ascending colon in the right iliac fossa. Several similar cases of less degree have also been operated upon successfully.

DOCTOR DONOVAN, in closing the discussion, said that he had operated on three babies with volvulus, aged ten, twelve and twelve days, respectively, all with acute obstruction. This child who had vomited since birth probably originally had one turn of the intestine around the superior mesenteric artery for some time, and the remaining turns developed until there was complete obstruction. In all three cases, the findings at operation were identical.

CHOLECYST-GASTROSTOMY IN AN INFANT THREE MONTHS OLD FOR CONGENITAL ABSENCE OF COMMON BILE-DUCT

DR EDWARD J DONOVAN presented a female child, aged three months, who was admitted to St Luke's Hospital, October 4, 1932, with the following history.

Mother first noticed clay-colored stools and dark color of urine when

baby was two weeks of age. Jaundice was first noticed by mother one week later. Clay-colored stools, dark-colored urine and jaundice have always been present since that time. Baby has vomited a great deal since birth, but there has never been any bile in vomitus. She is an only child. Father and mother are alive and well. When admitted she was found to be well developed except congenital club feet. She was well nourished, but definitely jaundiced.

Her liver was large, being three fingers below costal margin. Spleen palpable.

October 20, 1932, the abdomen was opened through a right rectus incision. The liver was found to be very large and of a dark green color, but with a smooth surface. Her gall-bladder was very large and was filled with bile. Exploration of the common duct region disclosed a large structure which appeared to be the common hepatic duct into which cystic duct entered directly. There was nothing visible or palpable in the normal location of the common duct below the junction of cystic with common hepatic duct. By exploration with a needle, bile was obtained from the common hepatic duct and from the gall-bladder. Cholecyst-gastrostomy was done by suture, just proximal to pylorus. Convalescence was uneventful. Sclera and skin were free from jaundice in forty-eight hours. The first stool, forty-eight hours post-operative, was positive for bile. Wound healed by primary union. Bile index, 20 one week post-operative, 10 on discharge from hospital on fourteenth day, seven months post-operative, no jaundice, normal in every way.

DOCTOR DONOVAN said that he had explored about ten such cases, and this is the first one that he had found in which enough of the bile-duct system was functioning to enable an anastomosis to be made to either the stomach or duodenum. In two of these cases, there was no gall-bladder present. In the others, the duct system was otherwise undeveloped. The liver is the first gland of the digestive tract to appear. In a three-millimetre embryo a longitudinal ridge-like projection develops from the ventral side of the foregut just caudal to the stomach, that is, in the portion of the foregut later to become the duodenum. The cephalic part of this evagination is solid and is destined to form the liver proper. The caudal portion is hollow, continuous with the lumen of the gut, and is to form the gall-bladder and the ducts. Both ends of the hepatic evagination become constricted from the gut until its only connection with the gut in an eight-millimetre embryo is a narrow cord of cells, the anlagen of the common duct. The glandular portion of the liver grows very rapidly and is attached to the common duct portion only by the hepatic duct. Both parts of the hepatic evagination grow into the ventral mesentery, that portion involved in the formation of the septum transversum later to form the diaphragm. During the third month, the liver fills most of the abdominal cavity. After the fifth month, it grows more slowly, although at birth it forms about one-eighteenth part of the body weight.

From an embryological standpoint, it is a little difficult to explain the findings in this case. With as careful a search as was possible without jeopardizing the child's chances of withstanding the operation, they could neither see nor feel any structure that had the appearance of a duct below the junction of the common hepatic with the cystic. He added that if these

RUPTURE OF THE LONG HEAD OF THE BICEPS

cases are not operated on before the age of six months it is difficult to get the liver to function

DR CHARLES E FARR said he had never been fortunate enough to accomplish anything for these cases as they were all inoperable, either having no external biliary apparatus whatever or an anomaly which would not permit of an anastomosis. According to his study of the literature on the subject about 16 per cent of these interesting anomalies were amenable to surgery. Most of the successes were in cases where a great cystic dilatation of the ducts was found.

SPLENECTOMY FOR BANTI'S DISEASE PERFORATED DUODENAL ULCER NINE MONTHS LATER

DR EDWARD J DONOVAN presented a man, an Italian, aged fifty-eight, who was admitted to St Luke's Hospital, April 1, 1929, with a history of having had tarry stools for the previous six days, and a similar attack ten months ago. He showed secondary anæmia, palpable liver and palpable spleen. At exploration, they could find no ulcer of the stomach or duodenum although these structures were not opened. The spleen was considerably enlarged, and adherent to the surrounding structures. It was removed. Pathological report showed chronic interstitial splenitis or what is called Banti's disease. Convalescence was uneventful, and he left the hospital on the eighteenth day. He remained free from symptoms until nine months later, when he was readmitted on account of a perforated duodenal ulcer.

At operation by Doctor Shore a small perforation of an ulcer was found on the anterior wall of the first part of the duodenum. There was no induration about this ulcer so that it was inverted. Convalescence was uneventful. He adhered to no particular diet, but gained weight and did very well until last August, when he was found to be suffering from hyperthyroidism. He was admitted to the medical ward at St Luke's to be prepared for operation. He left against advice because he had to stay in bed. He has since received five X-ray treatments to his thyroid, and he states that he is very much improved. Since the onset of hyperthyroidism he has lost forty pounds, but he has gained five pounds in the last two weeks. It is now four years after his splenectomy, three and a quarter years after the suture of his ulcer, and he is entirely free from symptoms. Red blood count at the present time, 5,000,000. Hæmoglobin, 98 per cent.

RUPTURE OF THE LONG HEAD OF THE BICEPS

DR WILLIAM CRAWFORD WHITE presented a young man, a flying trapeze performer who is noted for his ability to do the triple somersault in the air. As he finishes this feat he is caught by his brother who is hanging down from a trapeze across the other side of the wide space in the circus tent. The feat is very difficult and, unlike other features of the trapeze performance, it is difficult to time so that his brother seizes him sometimes by the wrist, by the forearm, or even by the elbow. At this moment the arms are hyperabducted and the forearms slightly flexed.

About one year ago, during a performance, when the patient was grasped by his brother, he felt a sudden cramp-like pain in his right arm, and with difficulty he was able to reach his platform. When seen the next morning there was no ecchymosis or swelling, but when he flexed his forearm, the bulge of his biceps was displaced downward and inward as compared to the other

biceps muscle It was decided that the long head of the biceps muscle had been ruptured After about two weeks the patient was able to return to full duty, and he continued at his work until thirteen days ago, when he had another accident in the same part of his act Just as his brother caught him, the right arm was markedly abducted and thrown backward, to be immediately followed by a severe pain at the shoulder-joint and a sense of displacement at the head of the humerus While his brother was still holding on, he threw himself about and felt a snap at his right shoulder-joint with some relief of pain and return of ability to use his arm again He has not worked since

This case illustrates the use an athlete can make of his right arm with the long tendon ruptured, and also a possible late result when hyperabduction and external rotation are used At present, also, it appears that the infraspinatus and the teres minor may have ruptured at the first accident, for there now is atrophy at these muscle sites The author was anxious to know if any other treatment than palliative is indicated in a man who must use violent exercise in his occupation

DR HENRY H M LYIE said that he had never had the opportunity of treating a fresh rupture of the body of the biceps He had, however, been successful in treating them when the tendinous portion had been ruptured and he had shown such cases before this society The last one had received his accident while performing on the trapeze and had sheared off the tendon at its insertion to the radius

DR CHARLES E FARR said that he had seen several of these ruptures of the biceps muscle or tendon One in which the long head of the biceps was torn from its origin was operated upon but aside from the cosmetic improvement there did not seem to be any great progress in function Rupture of the muscle belly could be easily closed but it was doubtful here if the function was ever much better For an athlete under tremendous strain, such as this man, it was hardly to be expected that closure of the gap would give him sufficient return of power to enable him to perform these dangerous feats

DOCTOR WHITE, in closing the discussion, said that he had advised this patient to have an operation after the first accident but it had been refused, on the ground that this had happened to many performers who after a while had been able to carry on their work the same as before

ANTERIOR GASTROENTEROSTOMY

DR GUILFORD S DUDLEY presented a man, forty-two years of age, who was admitted to the Second Surgical Division of Bellevue Hospital with a history of attacks of sharp epigastric pain of eight years' duration Three weeks prior to admission the pain had become dull and constant and was relieved by vomiting He had lost seventeen pounds in weight during the past four years Physical examination was negative His blood showed 3,000,000 red blood-cells with 70 per cent of hæmoglobin Radiographical examination showed no organic lesion of stomach or duodenum, but did show marked stasis in the second portion of the duodenum Pre-operative diagnosis was duodenal stasis

At operation, February 15, 1933, an egg-sized retroperitoneal mass was found at the level of the duodenojejunal junction whose consistency was

HÆMOLYTIC JAUNDICE

strongly suggestive of malignant neoplasm. The parietal peritoneum, the liver and the cul-de-sac of Douglas were studded with milium cysts. There were very many enlarged lymphatic glands within the mesentery of the small intestine. No primary focus within the stomach, large gut or prostate could be detected. The walls of the upper jejunum were thickened and oedematous. This finding was interpreted to be due to interference with the return venous circulation by the mesenteric glands. A gland, removed for biopsy from this region, was reported to reveal chronic inflammation, but no neoplasm. Hence diagnosis remains obscure.

In view of the above findings and of the impracticability of performing posterior gastroenterostomy, an anterior anastomosis between the stomach and distal jejunum was done. No enteroanastomosis was added. Since operation his progress has been favorable. He continues to have moderate pain and some gaseous eructations, but has not vomited and has gained some weight. A post-operative radiographical examination April 24, 1933, shows a functioning anastomosis at the pyloric portion of the stomach with moderate degree of dilatation of the proximal small intestine. It also shows considerable narrowing in the mid-portion of the stomach with intact rugal folds suggesting that this appearance is due to extrinsic causes.

Doctor Dudley presented him, not from the viewpoint of diagnosis or prognosis, but with the thought of introducing the subject of anterior gastroenterostomy. He had performed this operation in the presence of posterior gastrojejunal ulcer, in the presence of neoplastic lesions during an unfavorable immediate post-operative course following posterior gastroenterostomy and upon other selected occasions—but had never felt that it accomplished as efficient emptying of the stomach as does the posterior operation. This impression has been more or less substantiated by the few follow-up X-ray series that he had seen. Recently he had encountered a large gastrojejunal ulcer at the site of an anterior gastroenterostomy done at another institution. The present case is the only one in which enteroanastomosis has not been included as part of the procedure and its omission does not appear to have influenced unfavorably the outcome.

DR JOHN A. MCCREERY said that he had little enthusiasm for anterior gastroenterostomy, although he had used it in a few cases of extensive pyloric carcinoma in which the posterior operation had been impossible. He had always done an enteroenterostomy in addition, with the exception of a few cases in which he had done a retrocolic anterior gastroenterostomy. He thought that the enteroenterostomy was an important part of the procedure in the case of an antecolic anastomosis. Doctor Dudley was fortunate in that an early secondary enteroenterostomy had not been necessary in this case and thought that it would be advisable to keep the patient under observation as even at this late date gradually increasing angulation might make a secondary operation necessary.

HÆMOLYTIC JAUNDICE

DOCTOR DUDLEY presented a woman, aged twenty-eight years, who was treated for the past five years in the out-patient department of Bellevue Hospital for chronic ulceration of the lower thirds of both legs. From the beginning and throughout this period of treatment the continued presence of an anæmia without improvement was recognized. No determination of the cause

of this anæmia was made. In December, 1932, she was referred to the hæmatological clinic of the Second Medical Division where a detailed work-up led to the diagnosis of familial hæmolytic icterus. This was based upon five positive findings: (1) jaundice, (2) increased fragility of the erythrocytes, (3) enlarged spleen, (4) duration of illness (five years), (5) periodic rises in the reticulocyte count.

At the age of five she and a younger sister had attacks of jaundice which, in both instances, resolved themselves completely. This sister now has an anæmia and is being studied for diagnosis. There are five brothers and sisters living and well. During the past year, the patient had become definitely weaker, had noted marked fatigue and had lost a moderate amount of weight.

Examination showed a slight icteric tinge to the conjunctivæ and a firm, enlarged spleen whose free edge was about one inch below the costal margin. The icteric index December 9, 1932, was 35. One month later it was 24. Van den Berg direct delayed, indirect positive. During this month she received iron and copper medication despite which her hæmoglobin dropped from 52 to 38. On December 16, 1932, a fragility test showed initial hæmolysis at 48, a complete hæmolysis at 44. The following morning initial hæmolysis at 48, complete hæmolysis at 42. Blood chemistry was normal. Wassermann reaction, negative. The urine contained no bile pigment but did show a small amount of urobilin. The fæces contained bile. Gastric analysis of the fasting stomach showed free acid of 25 and total acid of 55. After histamine free acid of 27 and total acid of 41. On January 9, 1933, the blood showed 26 per cent reticulocytes, on February 1, 1933, 11.2 per cent and on February 7, 1933, 5.3 per cent. There was achromia, poikilocytosis, anisocytosis and microcytosis. The clotting time was one minute, fifty seconds.

She was transferred to the Second Surgical Division and February 8, 1933, her spleen was removed and a specimen of bone-marrow from the sternum obtained. That there might be no disturbance within the bone-marrow, a pre-operative transfusion was not given. Immediately after operation one 500-cc whole blood transfusion was given. Her gall-bladder was not palpated so that he was unable to state whether or not gall-stones co-exist in this case.

Her post-operative recovery was uninterrupted. The bone-marrow was reported to show normoblastic hyperplastic marrow which is probably due to excessive production of erythrocytes. The pathological report of the spleen was intense congestion. Since leaving the hospital progressive improvement has continued. Her icteric index is now 2, her reticulocyte percentage 2, her red-cell count 5,100,000 and her hæmoglobin 85 per cent. The curves charted on this lantern slide show graphically the changes in the red-cell count, the hæmoglobin percentage and the reticulocyte count. As no change in the fragility of the red blood-cells usually follows splenectomy, this examination has not been done since operation.

DR EDWARD J. DONOVAN remarked that hæmolytic icterus may be congenital or acquired. The congenital type shows a tendency to occur in more than one member of a family, and early in life. The acquired type occurs in middle life, is more severe and occurs more often in females. Either type shows striking results following splenectomy. Either type may show long remission, but even in the remission there is almost always some evidence of jaundice. The cause of the disease is unknown. Many cases show no change in the fragility of the cells after splenectomy although the jaundice disappears.

AN ANALYSIS OF TEN CASES OF HYGROMA CYSTICUM COLLI

This is against the theory that this is a primary disease of the spleen. Sixty per cent of these cases show pigment gall-stones and have attacks like biliary colic. It is easy to understand why these cases have been operated on for jaundice due to gall-stones.

The speaker had used the left subcostal incision for splenectomy about thirty-five times, and, so far, has had no post-operative hernia. This cuts across the six, seven, eight and nine intercostal nerves, but this apparently does not make the scar weak. The rectus muscle need not be cut, but if its posterior sheath is cut, the muscle may easily be retracted inward. This incision brings one directly on the splenic pedicle and gives an excellent exposure of the spleen.

AN ANALYSIS OF TEN CASES OF HYGROMA CYSTICUM COLLI

DR EMIL GOETSCH read a paper with the above title.

DR EDWARD J. DONOVAN queried what was the relation of infection to these hygromas. He had seen cases where the tumor increased rapidly in size in the presence of acute infection, such as acute tonsillitis, *etc*.

DR HENRY H. M. LYLE said his experience was limited to three cases. While he was an interne at St. Mary's Hospital for Children under the late Dr. Charles Dowd they had a case of a very large cervical hygroma extending into the axilla, he himself had demonstrated a similar case about twenty years ago before the Section on Surgery of the Academy of Medicine and ten years ago a case of a small one in the groin before this society.

DR MORRIS K. SMITH said that he had hoped the discussion would include types of treatment other than the operative. He had had one of these cases a year ago. Figi, of The Mayo Clinic, reported a series of thirteen cases in twelve of which radium alone was used. Doctor Smith finally decided to operate on his case. It proved to be unilocular instead of the more common multilocular type. Following operation the patient was given a course of X-ray therapy. When last seen, nearly a year after operation, there was no sign of recurrence.

DR HENRY W. CAVE said that in 1923 he had a case of hygroma of the abdomen, which had previously been diagnosed as a mesenteric cyst. The patient was an Italian boy, aged three years, with a markedly protuberant abdomen more pronounced on the right than on the left side. The appearance of the abdomen gave one the impression of a hugely distended mass with a large cystic tumor on the right side. On opening the abdomen no intestines were seen, but a dark, bluish-red membrane containing numerous blood-vessels presented into the wound. Cæcum, appendix, transverse colon were found pushed high up under the liver and spread out over the dome of a great cyst wall. Trocar puncture with suction was applied and about 850 cubic centimetre of dark red fluid drawn off. After opening into the large cyst, two smaller

cysts were found on the inside high up in the mother cyst. About 150-175 cc of fluid were evacuated from each of these smaller cysts. The mother cyst as well as the daughter cysts were packed carefully with gauze. It was generally agreed that these retroperitoneal hygromas developed from the vestigial lymph-buds. This cyst was, no doubt, a true hygroma of the retroperitoneal space. A follow-up, seven years post-operative, revealed that this child was in excellent condition. Doctor Cave asked if Doctor Goetsch had found any reason for believing there may be an opening between the lymph channels and the blood-vessels. Experiments have shown that there are types of South American monkeys who have a direct connection between the lymph and the blood-vessels.

DR ARTHUR S. McQUILLAN said that he had one case of a large monolocular cyst which dissected out very easily. He had another case, a girl of twelve years of age, in which the cyst was prolonged beneath the fascia and both sides of the neck. He had not been sure that he got it all out at operation but there had been no recurrence.

DR WILLIAM F. MACFLE said, in regard to the treatment of these tumors, he had one case in which the growth was associated intimately with the facial nerve. He exposed part of the mass and discovered it was hopeless to dissect it out without damage to the nerve. He packed the cystic cavities with iodoform gauze which was left in place for a few days and then gradually withdrawn. Eventually there was what appeared to be complete recovery. Does not the fact that the fluid does not coagulate militate as against the theory of lymphatic origin of these tumors?

DR CHARLES E. FARR said that he had worked up for the late Dr. Charles Dowd a review of the literature and an assembling of a list of cases. Since that time he himself had operated upon several cases of hygroma with successful outcomes. One in the submaxillary triangle and one in the groin were very interesting exceptions to the general rule of finding hygroma in the neck or axilla. One very remarkable cervical case in a small infant at St. Mary's Hospital for Children contracted erysipelas during the pre-operative period and was desperately ill. After prolonged treatment with many blood transfusions the child recovered and the hygroma completely disappeared.

DOCTOR GOETSCH, in closing the discussion, referred to the question of infection in hygroma. There was no history of infection in any of his cases associated with the onset of the hygroma. However, in one case in the course of the disease, there was a streptococcal infection which caused rapid growth of the tumor and a severe sepsis. In a review of the literature he had not found any reference to the fact that these hygromatous cysts were the result of infection. They may, however, easily become infected whenever there is an associated tonsillitis or pharyngitis. The late Doctor Dowd pointed out the danger of infection which has frequently caused a fatal outcome.

As to treatment other than operative, mention has been made of spon-

taneous retrogression particularly in cases which have been treated with radium. Doctor Goetsch felt that radium treatment and X-ray are of value in reducing the size of the tumor. The hygromatous tissue, being of lymphatic origin, is very sensitive to radium or X-ray and it might be advisable to give irradiation following operation. Irradiation is particularly of value in the very large tumors in very young children, under a year possibly, for here the operation might be a serious undertaking. In the small, particularly the unilocular tumors, the dissection is easy. In the large, multilocular cases dissection may be very tedious. With reference to the question of the possibility of an opening between the lymph and the blood-vessels, Doctor Goetsch said that he had been looking for this possibility but in no case in his experience was a communication found between the cystic tumor and the venous system even after diligent search with the probe and otherwise. In regard to palliative treatment the use of corrosive substances and even gauze packing might cause a sclerosis and a cure occur in the small tumors but that this method is impractical in the larger, multilocular cystic tumors made up of many cavities which do not communicate with one another. In fact, there are on record cases of spontaneous cure and perhaps also recoveries after infection, all of which indicates that the endothelium of these tumors is sensitive to any irritant and is probably readily destroyed. The difficulty, however, is in reaching all of the many inaccessible cavities. Minor surgical procedures may be and often are dangerous due to the possibility of infection which may result fatally. In some of the cases shown by him iodine was applied to the cavity from which the tumor was removed and there had been no recurrence. The application of iodine may have assisted in the sclerosis and cure. One would expect the fluid to coagulate if it is truly of the nature of lymph but it is probably not a true lymph since it does not coagulate upon cooling and in the uncomplicated cases the content of albumin and globulin is not high. This, however, does not exclude the lymphatic nature of the fluid contained in the cysts.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD OCTOBER 25, 1933

The President, DR. ALLEN O. WHIPPLE, in the Chair

THE BEVAN OPERATION FOR UNDESCENDED TESTES

DR. THOMAS H. RUSSELL presented five young men, varying in age from six to twenty-two years, upon all of whom he had operated during the past few months for unilateral or bilateral undescended testes. In all cases he had attempted to employ the Arthur Bevan operation as he had had the privilege of seeing him perform it in the Presbyterian Hospital in Chicago.

The usual hernia incision is employed, that is, an incision beginning at a point mesial to the anterior superior spine of the ilium and continued downward parallel to and over the inguinal canal to a point just below the middle of the external ring. When the external oblique muscle is reached and before it is divided if the testicle is found contained in its sac, at this site as is usual the sac surrounding the testicle is grasped with a hæmostat forcep and dissected free from the surrounding tissue except at its attachment above. The opening in the scrotum is then found and two fingers are introduced into the scrotum, freeing it within. A good-sized gauze pad soaked in saline is then packed into the scrotum, stretching it to its full extent. The external oblique muscle is then divided to the full length of the incision and Poupart's ligament exposed freely on its under side. The sheath of the rectus muscle at its attachment to the pubis is exposed and wiped free. The clamp attached to the sac surrounding the testicle is held up and the cord is dissected free by going through the internal abdominal ring. If a hernial sac is present it is dissected from the cord and divided about midway between the internal ring and testicle. This converts the existing congenital hernia into an acquired hernia, reserving the lowermost part of the sac to act as a tunica vaginalis for the testicle. The peritoneum forming the hernial sac is ligated at the entrance to the internal ring and the excess cut off. The vas and vessels are then dissected from the peritoneum well down through the internal ring until the vas and vessels are long enough to permit the testicle to drop freely into the bottom of the scrotum. This can always be done without dividing the vessels of the cord provided time and patience are given to the procedure. The internal ring is dilated and retracted with several narrow-bladed deep retractors. When the vas is free from the peritoneum it gives suddenly. This is a very delicate and tedious task and requires patience. The vas and vessels of the cord must be long enough to permit the testicle to extend to the bottom of the scrotum. The organ is dropped into the scrotum, then a purse-string suture is taken around the neck of the scrotum leaving the cord behind the suture. This is done to prevent the testicle from accidentally slipping up out of the scrotum. Occasionally, when an unusually short cord is found, it may be helpful to divide the deep epigastric vessels, as they sometimes act as a bar over which the cord has to come up before it begins to descend, thereby shortening it.

THE BEVAN OPERATION FOR UNDESCENDED TESTES

The hernia is then repaired in the usual way by suturing Poupart's ligament to the rectus sheath below and to the internal oblique and transversalis muscles above. The cord is not transplanted.

There is always some swelling of the testicle for a while after the operation but if care is taken in handling the organ this is greatly minimized. There may also be considerable ecchymosis of the scrotum if it is stretched too quickly and forcibly.

Doctor Russell was presenting these cases because he thought the results obtained by the Bevan operation, which is usually done in one stage, although he had performed it in two stages, justify its being used more frequently.

The question is frequently asked, "How can one determine before puberty whether an operation is necessary for undescended testicle?" We know that if an operation is necessary the earlier it is done the better the result. Many patients are told not to worry as the testes will descend at the age of puberty. Doctor Russell employed the Bevan test to determine whether an operation is necessary. This test consists of having the boy lie on a table and after the testicle is located if it can be pushed down into the scrotum, even though it does not remain there, it will descend when puberty is reached. If it cannot be pushed into the scrotum after the child is two or three years old, the chances are that it will not descend at puberty, hence, the earlier the operation the better.

DR CARL G. BURDICK thought these five cases were excellent results from the Bevan operation. In 1926, he had occasion to look up the operations for undescended testicle at the Ruptured and Crippled Hospital, there were over 500, 80 per cent of which had been followed. The satisfactory results, as far as the location of the testicle was concerned, were about 50 per cent, but only 15 per cent with normal-sized testes. Since that time he has been doing the Torek operation and has reported 137 cases in which the results were satisfactory. In 90 per cent the testes were normal in size and located in the bottom of the scrotum.

With the Torek operation one can almost promise that the patient will have a testis well down in the scrotum and normal in size. As far as the Bevan test for determining before puberty whether an operation is necessary, the speaker had never heard it called by that name but always examined very carefully a case diagnosed as undescended testicle, and found that in a fair percentage the testis could be forced down in the scrotum. He did not operate in these cases as he believed they should not be classified as undescended. He felt that the Torek was the operation of choice.

DR EDWARD W. PETERSON said that when two plans of treatment were under consideration that the only fair test was a trial of both methods. He had operated upon cases of undescended testicle by both the Torek and the Bevan methods. In his own experience he felt that any case that gave promise of a good result by the Torek operation could be assured of an equally good result by the Bevan technic, without the necessity for the second-stage operation. In his clinic, for the past six or eight years, thyroid and anterior pituitary extracts had been used, and he thought with benefit, in the cases that were being prepared for operation.

DR FRANZ TOREK said that the results in the three adults among these five cases were better than any he had ever seen in which orchiopexy was not done. Two of them were very good. The third case has a testis half way down but it is atrophied or it has not developed, which brought up the point as to why the speaker attached the testis to the thigh, it was not only to secure the proper degree of descent but also to give it a chance to get nourishment from a new source. He never made an artificial tunica vaginalis, he considered that to be objectionable because it interposed a tissue between the testicle and its new source of nutrition. In the two children presented the testicles are too high up, being placed about at the neck of the scrotum. They may possibly come down farther later, but it is not a satisfactory immediate result. It is well known that, even many years ago, there have been successful operative results in cases of unilateral non-descent, but only in favorable cases, namely, where the undescended testicle was of fairly good size and where a reasonable amount of scrotum was present. The question why the Bevan operation is so called has been a mystery to many. In 1899 Bevan described the separation of the cord from the vaginal process of the peritoneum, dividing the vaginal process transversely, dissecting its proximal end up to the internal inguinal ring and bringing the lower end down. This same procedure was described in Dennis' Surgery four years earlier in an article by William White who furthermore calls attention to the necessity of separating each and every adhesion to the cord. White laid no claim to originality but described it as though it had been the acknowledged method of procedure. And that appears to have been the case, for in 1880 Schuller described the same method, and likewise Nicoladoni in 1885, who went somewhat more into details. In the literature it was occasionally spoken of as the Schuller-Nicoladoni operation. As a matter of fact, after Bevan's first publication the operation was not spoken of as Bevan's. Only after his second article, four years later, in which he prefaced his description by stating that he had made some improvements which placed the operation in a position where it should be accepted as a standard procedure, did the profession take notice, for in this article Bevan said something that had not occurred to any one before, namely, that in some cases he divided the spermatic vessels. But as in other respects the method remained the same as that described by White, the profession, taking the hint that here was a standard procedure, called the division of the spermatic vessels the Bevan operation, as that was the only original part of the procedure. In 1929, Bevan stated that he had not divided those vessels in four or five years, so, after this step had been eliminated, Doctor Torek was unable to see what there was left of the Bevan operation. Nevertheless Bevan should be given full credit for having helped to awaken the interest of surgeons in the operative repair of undescended testis.

DR WILLIAM B COLEY stated that the method of operating upon the undescended testis evolved at the Hospital for Ruptured and Crippled be-

EMBOLECTOMY OF FEMORAL AND EXTERNAL ILIAC ARTERIES

tween 1893 and 1899 by Dr William T Bull and himself, was practically similar to the method described by Bevan, first in the J A M A , September, 1899, and later in the J A M A , September, 1903. Doctor Coley's first operation was performed in 1893, he divided the sac and sutured the lower end over the testes, he then dissected the cord as free as possible up to or beyond the internal ring. The testis was placed in the scrotum. In this case and in several others he closed the canal by the Bassini method. Doctor Bull, however, in 1893, in operating on another case, saw that by omitting the transplantation step of the Bassini operation, there was gained one-half inch or more in the length of the cord. This is one of the important steps noted by Bevan in his operation. Up to 1899, Doctors Bull, Walker and Coley had performed twenty-six operations for the undescended testis. They had given up transplanting the cord, and relied chiefly on a thorough freeing of the cord, cutting the fascial bands but not the vessels of the cord. While many of these cases were reported in their papers on the Radical Cure of Hernia published prior to 1899, they gave no special detailed account of the different steps of the operation. Bevan, in 1899, was the first to do this, hence the method has been designated, and, in the opinion of Doctor Coley, very properly, the Bevan method.

Doctor Coley believes the method has given by far the best results of any operation except the Torek, he still believes there is a large number of cases which can be treated just as successfully by the Bevan method as by the more complicated two-stage method of Torek. He agrees with Doctor Burdick that the Torek method gives a higher percentage of ideal results than does any other, but he believes it should be reserved for the more difficult cases in which it is not possible to bring the testis down to the bottom of the scrotum without tension.

Doctor Coley stated that as early as 1903 he advised against operating upon very young children, as advocated by Broca of France and also by Bevan. He still believes that it is unwise to operate on the undescended testis in children under ten years of age, except in cases with hernia difficult to control, for the reason that in many cases as the boy approaches puberty the testis descends into the scrotum spontaneously. Doctor Coley does not believe it is possible to determine beforehand by any such simple method as described by Doctor Russell, in just which cases it will descend, and in which it will not.

EMBOLECTOMY OF COMMON FEMORAL AND EXTERNAL ILIAC ARTERIES

DR DEWITT STETTEN presented a woman, aged fifty-eight years, who had been on the medical service of Dr Otto M Schwerdtfeger at the Lenox Hill Hospital from January 31 to March 14, 1933, under treatment for cardiac hypertrophy, with arrhythmia and auricular fibrillation, due to a mitral stenosis and insufficiency. She was re-admitted to the hospital April 22, 1933, because of dyspnoea, orthopnoea, and weakness of the right upper and lower extremities, and slight difficulty of speech, which had developed about eight hours previously. These last symptoms were ap-

parently due to a small embolism of the terminal branches of the left middle cerebral artery. Examination showed weakness of the right upper and lower extremities, with hyperactive reflexes on both sides and a Babinski, right. There was also a slight flatness of the right side of the face. Under the usual treatment the patient improved, but on April 25, 1933, some time around noon, she complained of sudden pain in and complete inability to move the right leg, foot and toes. During the afternoon when seen by Doctor Stetten her right lower extremity from the mid-thigh down was cold to the touch, pale and slightly mottled and bluish, almost cadaveric in appearance. She was unable to move that extremity. There were no reflexes and there was definite, though not complete, anaesthesia to pain, touch and temperature of the entire leg and foot. No femoral, popliteal, dorsalis pedis or posterior tibial pulse could be felt. The left leg was warm, normally pinkish in appearance, the reflexes were active, the sensations were relatively normal, and the femoral and dorsalis pedis pulse were strong, but the popliteal and posterior tibial pulse could not be felt. On the inner side of both feet and ankles and on the inner side of the left calf were some small superficial varices. Oscillometer readings with blood-pressure at 120 on the left thigh and calf were practically normal, 5 and 3 respectively, on the right side there were absolutely no oscillations of the needle from the knee down, and the very slightest movement in the mid-thigh. The temperature was 101.4° , the pulse, 80, and irregular, the blood-pressure, 118/80. The heart showed the characteristic signs of hypertrophy with the typical murmurs of a double mitral lesion. It was fairly well compensated. A diagnosis of an embolus of the right common femoral, probably extending up as high as the external iliac, was made. The chances were against a riding embolus of the common iliac, because of the completely normal condition of the left lower extremity, and it was decided to attempt to extract the embolus.

About seven hours after the initial symptom, the operation was performed under local anaesthesia. An oblique incision was made in the upper thigh, and the femoral artery was exposed in Scarpa's triangle from Poupart's ligament downward for about four inches. It appeared to be a relatively small vessel. There was no visible nor palpable pulsation. With tapes above and below for traction and hemostasis, a longitudinal incision was made through all the coats of the artery and a long, thin soft, dark-red thrombus about three centimetres in length was exposed and removed. It was not adherent. The vessel did not appear to be particularly atheromatous and the intima was smooth. On removal of the thrombus, there was a free flow of blood from the distal portion of the artery, but as yet no free flow from the proximal portion, indicating still further occlusion above. An attempt was made to remove the remaining piece of the thrombus with a forceps, but without success. The proximal portion of the vessel was then irrigated with normal saline solution and a piece of the thrombus, nearly two centimetres in length and considerably thicker than but of the same character as the other thrombus removed was ejected from what was apparently the external iliac artery under Poupart's ligament (Fig 1). This was followed by a free flow of arterial blood. A large probe was then introduced into the vessel for about ten inches in an attempt to dislodge any remaining thrombus, and none could be found. The arterial wound was sutured with a paraffin-oiled continuous silk suture. Although, after the closure of the artery, there did not appear to be a true expansile pulsation at the site of suture, there was a distinct propulsive pulsation of the vessel immediately above the suture line, which had not been present before,

indicating at least that the patency of the lumen had been extended upwards. It was felt that, even if a complete re-establishment of the arterial blood-stream through the normal original channels had not been accomplished, at least sufficient of the thrombus had been extracted to permit of fairly satisfactory collateral circulation through previously occluded anastomotic branches. A further search, therefore, for any remaining thrombus seemed unnecessary, and the skin was sutured. The leg was wrapped in absorbent cotton and placed under an electric light cradle.

Immediately following the operation, the circulation of the affected extremity seemed decidedly improved. There was less pain, the leg and foot became warm, and the cyanotic pallor changed to a pinkish hue. Sensation also improved and toe motion promptly returned. The right femoral pulse could always be felt very definitely after the operation, and on May 1, 1933, a very faint dorsalis pedis pulse also seemed to be present. The patient's temperature gradually dropped and reached normal four days after operation, where it remained. The wound healed by primary union. The extremity gradually became quite normal, the pain almost entirely disappeared and the patient was allowed up June 5, 1933, at which time the



FIG 1—Embolus removed from common femoral and external iliac arteries

oscillometer needle showed a slight response in the right leg and quite a definite one in the right thigh. The patient was discharged from the hospital July 13, 1933, and since then has apparently been fairly well. She is able to get around quite satisfactorily, although she drags her right leg somewhat, undoubtedly because of the weakness following her mild hemiplegic attack prior to the embolic occlusion. She has at times some pain in the right great toe, especially when she has been up on her feet for a longer period of time. Examination shows the right lower extremity in feel and appearance very much like the left—warm and quite normal in color. The patellar reflexes on both sides are active. There is a Babinski, right. All sensations are quite normal and acute on both sides. There is still a strong left femoral and dorsalis pedis pulse, but the popliteal and posterior tibial cannot be felt. On the right side there is a good femoral pulse, but it is somewhat weaker than on the left. No popliteal, dorsalis pedis nor posterior tibial pulse can be felt on the right side. At present the oscillometer readings with blood-pressure at 115 are right thigh, 3, right leg, $1\frac{1}{2}$, left thigh, 7, left leg, $2\frac{1}{2}$.

Doctor Stetten added that much had been written in recent years on the subject of peripheral embolectomy and a fair proportion of the cases reported had been very successful. The speaker had attempted it on a number of occasions, but this was the first time that he is able to report a rescued limb. All the other cases of circulatory obstruction of an extremity

due to embolism in the main artery, which he has observed have resulted in a loss of limb or life, and generally of both—either with or without embolectomy. It may be that in this case, as has been indicated, the operative procedure did not directly completely restore the normal arterial circulation at the time of operation, but it is quite certain that it did effect an immediate and definite improvement in the circulation—probably by establishing a collateral flow either through the deep femoral or the anastomotic branches from the internal iliac, the orifices of which may have been blocked by the thrombus. Whether the ideal anatomical restitution of the circulation has been made by the operation or not is really not of vital importance as long as the practical physiological result of maintaining the nutrition of the limb is obtained, even if this is done by indirect means through collateral vessels. At any rate, the situation calling for this surgical intervention is usually so desperate, the operation itself is such a very simple, minor procedure and can so readily be done under local anæsthesia without the slightest risk, even in critically ill patients, that the attempt is certainly justifiable in suitably selected cases, and nothing is lost should it fail.

DR HAROLD NEUHOF said that Doctor Stetten's case was an excellent illustration of the fact that restoration of the parts could occur without return of through circulation. The ideal objective was, of course, the restoration of normal circulation after embolectomy. In the literature are a number of satisfactory clinical results and yet the return of through circulation at the site of the embolus has not been proven to have occurred in any of the reported cases, or, at the most, in one or two. However, the results that have been obtained cannot be conceived of as in the nature of an accident any more than one could picture the result in Doctor Stetten's case as an accident. It is fair to assume that his case would have gone on to progressive gangrene if embolectomy had not been employed. What then had been gained by operation in his case since at least partial occlusion at the site of embolectomy followed? It was Doctor Neuhoof's opinion that the result was obtained because the removal of the embolus permitted circulation through collateral branches. It also permitted at least some blood flow through the trunk of the vessel. It was at least an open question if one should attempt the Carrel technic without being familiar with its niceties. There are inherent dangers in the application of that technic when one is dealing with a diseased vessel wall or a vessel wall altered as a result of the lodgment of the embolus. With Carrel technic and the effort at a perfect restitution of circulation, appreciable thrombi may form at the site of suture in an altered vessel wall, to be carried down and lodged at a lower point in the extremity. The increasing danger of gangrene with lower lodgment of emboli is of course well known.

The difference between results of ideal embolectomy and arterial obliteration is well exemplified by two cases shown some years ago by Doctor Neuhoof. One was the rare instance in which an embolus was removed from a popliteal artery shortly after its lodgment and through circulation occurred and persisted. This patient had a useful extremity but suffered recurring attacks of claudication and other evidences of interference with circulation.

ANAL SPHINCTEROPLASTY FOR TOTAL INCONTINENCE

These were presumably due to scar tissue at the site of the arteriotomy and suture. In the other case an obliterative endo-aneurismorrhaphy of the popliteal artery had been performed. There were no untoward manifestations and the patient could walk miles without symptoms.

In the last case on which the speaker carried out an embolectomy he proceeded on the assumption that the essential objects were to remove the embolus, permit passage of blood through the branch of the artery above which the embolus was lodged, and to narrow the lumen of the incised artery so that large thrombi would not be carried down into the extremity. The result in this patient, an old man with an embolus lodged at the junction of the axillary and brachial artery, was excellent, despite the fact that there was no appreciable through circulation at the site of arteriotomy and suture. It was important to bear in mind that limbs have been retained in instances in which embolectomy has been advocated and operation refused. This has been particularly the case with embolic block at high levels in extremities. Specifically, he has seen instances of blockage at the bifurcation of the abdominal aorta in which bilateral gangrene of the extremities appeared impending if nothing were done and yet there was full or almost full recovery without operative intervention. He believes that operation should not be advocated for the riding embolus of the abdominal aorta and should not be advised in all cases of arterial blockage in the extremity itself. It is well to observe the case for a few hours in order to try to come to some conclusion as to whether embolectomy should or should not be performed. This viewpoint almost automatically excludes the idea of embolectomy as an operation to be performed at the earliest possible moment after a prompt diagnosis has been made.

DOCTOR STETTEN, in closing the discussion, said he thought Doctor Neuhof had given the impression that peripheral embolectomy is a difficult and dangerous procedure, but it is really very simple and quite without risk. With a little practice on the animal and the cadaver anyone can become quite expert in the Carrel technic of arterial suture, especially on an artery the size of the common femoral. In the speaker's opinion the operation is thoroughly justifiable in suitable cases. He is convinced that in this case there was no accidental recovery and that the patient's limb would never have survived without the operation. It really makes very little difference if the result is not perfect anatomically so long as the limb has been saved.

ANAL SPHINCTEROPLASTY FOR TOTAL INCONTINENCE

DOCTOR STETTEN presented a woman, aged thirty-eight years, who was admitted to the Beth Israel Hospital November 4, 1932, with a history of having been operated on elsewhere February 29, 1932, for what was apparently a large perirectal abscess to the right of the anus. Immediately after the operation the patient became totally incontinent of feces and had since regained no control whatsoever. Rectal examination showed a wide gaping, anal orifice, with marked scarring on the right side and absence of rugæ. The rugæ on the left side were still present (Fig 2). There

was a tendency toward prolapse of the anal mucosa. Digital examination elicited no sign of sphincteric action. When the patient was requested to make a voluntary effort to close her anus, the left half of the sphincter merely shortened and thickened in the attempt. It was obvious that much

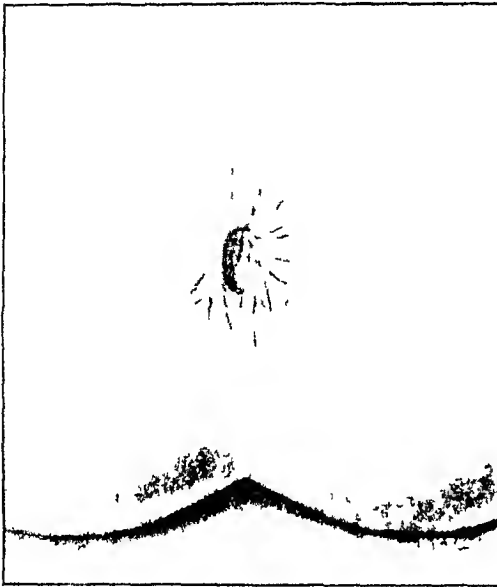


FIG. 2—Total incontinence of rectum due to destruction and cicatrization of right half and retraction of left half of sphincter and following infection and operation.

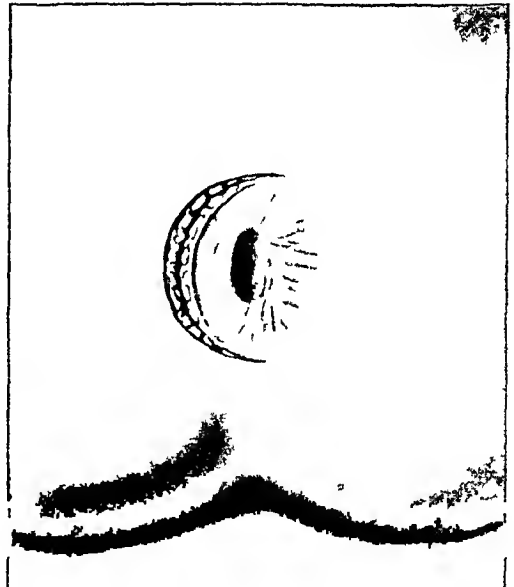


FIG. 3—Crescentic incision on diseased side.

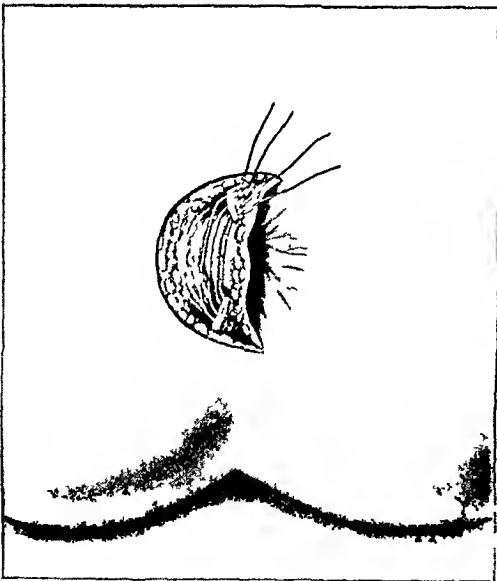


FIG. 4—Exposure of ends of remainder of external and internal sphincters. Two mattress sutures placed through ends of remainder of external sphincter.

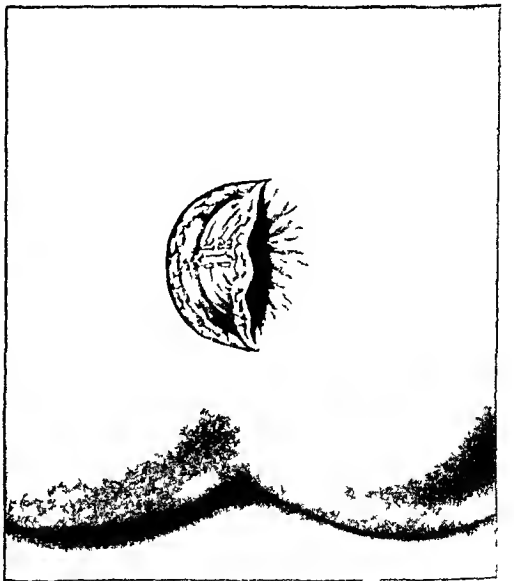


FIG. 5—Two mattress sutures of external sphincter and three sutures of internal sphincter tied.

of the entire right half of both the external and internal sphincters for an arc of 180° had been destroyed by the infection and previous operation, and that the left half had retracted but was still more or less preserved.

ANAL SPHINCTEROPLASTY FOR TOTAL INCONTINENCE

It was felt that an attempt at repair was warranted, especially as the operation was without risk and there was nothing to lose should it fail. Accordingly, after a most careful pre-operative preparation, including several days of very thorough catharsis, colonic irrigation, and fluid diet, she was operated on under spinal anaesthesia November 17, 1932. A crescentic incision was made over the scar to the right of the anus (Fig 3), and, anteriorly and posteriorly, the ends of the remaining left half of the sphincter were quite definitely exposed and readily recognized, lying almost in the median line. The dissection was extended upward somewhat and fibres of what was apparently the internal sphincter quite widely separated were also exposed (Fig 4). A No 22 F soft rubber catheter was placed in the anus

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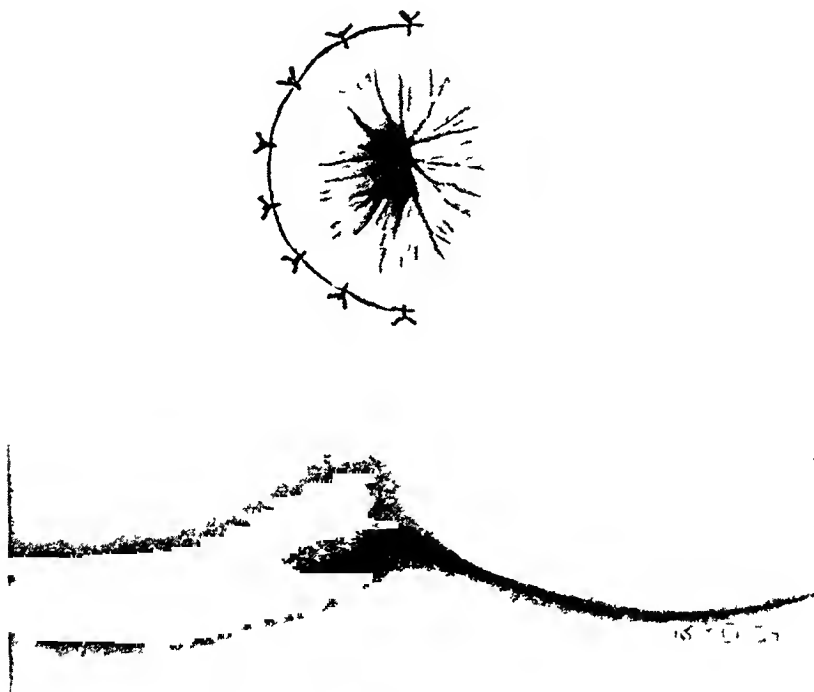


FIG 6—Skin sutured and anus restored

and the two ends of the remaining left half of the sphincter were easily brought together so as to complete the circle with two chromicized catgut mattress sutures. The separated fibres of the internal sphincter were also approximated with three simple interrupted chromicized catgut sutures (Fig 5). The skin incision was then closed completely without drainage with interrupted chromicized catgut sutures (Fig 6). A small dressed rectal tube was left in the anus.

For eight days the patient was kept on a fluid diet and constipated, and then a small olive-oil retention enema was given through the rectal tube, followed by a colonic irrigation. This was given daily with milk of magnesia, two drams t.i.d. Ten days after operation the patient had a relatively normal soft bowel movement, over which she had good control. Aside from a small fistulous opening, which developed in one of the an-

terior skin stitch holes, which closed spontaneously within two months, the wound healed by primary union with apparent union of the sphincter suture lines. Except when she has very loose bowel movements from a dietary indiscretion or from taking a cathartic, she has practically perfect control, and can now again lead a normal life. She has gained fourteen pounds in weight since her operation. She is taking regular active sphincteric exercises twice daily, which have further improved her control even over her loose movements. Examination at the present time shows a tightly closed anal orifice, plainly re-formed rugæ on the right side, and definite sphincteric action when the patient voluntarily closes her anus, which can be verified by visual inspection and digital examination. The speaker said that the essential factors in the success of this type of operation are the very thorough pre-operative preparation with fluid diet and complete emptying of the intestine, the protracted post-operative constipation also with fluid diet, and the very careful primary moving of the bowels thereafter.

INOPERABLE LYMPHOSARCOMA OF THE CHEST CONTROLLED FOR FOUR YEARS BY COLEY'S MIXED TOXINS AND IRRADIATION

DOCTOR STRITTEN presented a man, aged sixty-two years, who first came under his observation November 25, 1929, complaining of an uncomfortable feeling in the lower portion of the right side of the back, radiating downwards and across the lower spine. This symptom had begun about a year previously, and about six months later he first noticed a soft growth in this region, which had been gradually increasing in size. On the right side of the back, just lateral to the spine and running from the sixth to the tenth ribs, was a large, protruding, hemispherical, smooth, soft, semifluctuating, insensitive tumor adherent to the chest-wall, and apparently lying beneath the back muscles. It protruded about three inches from the chest. Percussion over the right lower chest was flat, and voice and breath sounds were absent. There were no enlarged lymph-glands. The blood count showed a slight secondary anæmia, but was otherwise relatively normal. The weight was 145 pounds. X-ray examination revealed a dense shadow filling the lower half of the right chest, probably due to solid tissue. There was no evidence of any bone invasion, either in the ribs or vertebrae.

November 30, 1929, under local anæsthesia, the mass was aspirated, but the needle evidently entered solid tissue as no fluid could be withdrawn. A probatory incision was then made, and a soft, pinkish, friable, homogeneous tumor was entered, lying beneath the muscle layer of the back. A specimen was excised for microscopical examination. The pathological report by Dr. F. D. Bullock was atypical lymphosarcoma, largely of the lymphocytoma type. The structures consisted, for the most part, of a diffuse growth of lymphoid cells, many of which showed mitotic figures. In a number of places, there was a formation of follicles with germ centres, the cells of which were actively proliferating. The stroma was generally very scanty, although in places the tumor was penetrated by thick, fibrous or hyaline trabeculae. The muscles of the back were extensively infiltrated by the growth. It was obvious that any radical operative interference was out of the question. The patient was immediately put on deep X-ray therapy over the lesion and started with a course of injections of Coley's mixed toxins. He was peculiarly resistant to the mixed toxin injections, which were given intramuscularly, and also into the tumor, and not until he had had eight minims injected did he show any decided reaction. Under the combined X-ray and mixed toxin treatment, the external tumor rapidly diminished.

INOPERABLE LYMPHOSARCOMA OF THE CHEST

in size, literally shrinking visibly from day to day, so that by December 25, 1929, it had completely disappeared. With its disappearance the flatness and absent voice and breathing over the lower right chest also diminished. The injections of mixed toxins were discontinued January 16, 1930, but intensive irradiation over the right back and chest was continued at frequent intervals. During the treatment the patient's weight dropped to as low as 133 pounds, but with the disappearance of the tumor, the clearing up of the chest, and the discontinuance of the mixed toxins, he began to regain his weight. On February 21, 1930, X-ray examination showed that the pathology in the right lower chest had completely disappeared.

In May, 1931, the patient complained of severe pains in the back with pressure in the right upper abdomen. He did not look well, but there was no evidence of recurrence either on routine examination or by a very thorough X-ray investigation. He was relieved by another series of X-ray treatments over the right and left lumbar and liver regions. On March 12, 1932, although there was no external evidence of tumor recurrence, an X-ray examination showed some flattening and elevation of the right vault of the diaphragm, and what was apparently a pleuritic effusion in the left chest. He was somewhat improved by another course of irradiation of both chests, but again had a setback in April, when he complained of shortness of breath and a slight cough. Another course of X-ray therapy over both lower chests afforded marked relief. X-ray examination on September 13, 1932, showed comparatively normal conditions, except that there was some thickening of the pleural shadow and pulmonary markings in the right superior mediastinum, and rather heavy right lung root shadows. About this time he presented himself with a smooth, freely movable, enlarged, cervical lymph-gland, about the size of a hazelnut, in the left supraclavicular region. September 27, 1932, this was excised under local anæsthesia. It was found to be an encapsulated growth, obviously an enlarged lymph-gland. On section it was pinkish, soft, friable and granular, and had the gross characteristics of neoplastic involvement. Microscopical examination showed a lymph-node largely replaced by a tumor composed of compact masses of round and rather granular cells containing round vesicular nuclei, many of which were in some stage of mitotic division. The cells grew diffusely or in large and small masses, which were supported by lymphoid tissue. This tumor differed from the original tumor in that the former was composed of cells of the lymphocytic type, while the present tumor was derived from reticulum cells, and had to be regarded as a reticulum-cell sarcoma of a cervical lymph-node. X-ray treatment was then given to the left supraclavicular region. Again in March, 1933, the patient noticed similar glandular swellings in both the left and right submaxillary regions. The one on the left side was about the size of a small egg, and on the right side the size of a hazelnut. Both were firmly attached to the deeper parts. They were not removed and under X-ray therapy these nodules also completely disappeared in about five weeks.

In the beginning of May, 1933, the patient complained of pain and swelling of both wrists, especially the right. The right wrist was markedly swollen and tender, and the left moderately so. As he had a temperature of 101° , it was suspected that this might be an intercurrent rheumatic arthritis, but when it did not subside under the routine antirheumatic treatment, an X-ray examination of both wrists was made. It showed several small, well-defined areas of rarefaction in the lower end of the right radius and a suspicious area of a similar character in the left navicular. On the theory that these were bone metastases, a thorough course of X-ray therapy

to both wrists was begun with prompt recession of the swelling and symptoms. At about the same time another glandular nodule the size of a hazelnut developed in the right supraclavicular region, which again completely disappeared in about a month under X-ray therapy. At the present time the patient is quite free from any evidence of disease, except that the wrists are still slightly thickened, especially the right. On X-ray examination, his chest is quite as normal as it was a year ago. He weighs 160 pounds, which is his maximum weight, and is twenty-seven pounds above his lowest weight in the early part of his illness. Although he is a trifle pale, his general health appears to be very good. Except in the beginning of his illness, when he was receiving the mixed toxins, and for short periods of a few days each, when he was temporarily disabled, he has worked quite steadily at his job as bookkeeper.

It is well known that this type of tumor is peculiarly radiosensitive, at least for a time, but it is also generally conceded that the possibility of an ultimate cure is very doubtful. As a rule, after a year or two, response to irradiation decreases, and eventually is lost entirely, and the patient generally succumbs to recurrences or metastases. The length of time that this case has been kept under control warrants its presentation. Although it is by no means suggested that the patient is cured, at least the disease has been kept in check for four years by massive X-ray dosage, which has been unusually well tolerated. One interesting feature is the apparent difference in the pathological character of the cervical lymph-gland lesion as compared with the primary growth. The question might be discussed whether these two lesions are independent growths or whether the lymph-gland disease is simply a metastasis with metaplasia owing to its location. One fact is quite clear—namely, that the lymph-gland lesion responded just as readily to the X-ray therapy as did the primary tumor.

DR WILLIAM B. COLEY called attention to the case of intrathoracic tumor presented to the New York Surgical Society by Dr. Howard Lihenthal January 12, 1927, which, he believed, in some respects simulated the case presented by Doctor Stetten. He showed two lantern slides of this case: (1) a large intrathoracic tumor before treatment, and (2) one taken seven years later, showing a normal chest. This patient, a female aged four years, came under Doctor Lihenthal's care on April 12, 1924, with a history of having had an intrathoracic tumor for nearly a year, progressively increasing in size until March 16, 1924, when the patient had developed paraplegia. Rontgenological examination showed a large mass in the right chest extending across the median line into the left chest above the heart. The opacity of the right side occupied the lower two-thirds of the chest and extended to the left above the heart where was a large shadow. There appeared to be partial erosion of the adjacent ribs posteriorly and also some erosion of the bodies of the neighboring vertebrae. There was a protruding subcutaneous mass covered with normal skin between the right scapula and the spine. Doctor Lihenthal performed a posterior thoracotomy, removing a portion of the tumor about the size of a golf ball. On microscopical examination, this was pronounced a highly malignant tumor. The specimen was later examined by Doctor Gross, who regarded it as a "hemangio-endothelioma," and by Doctor Ewing, whose opinion was "malignant cellular tumor of

embryonal type composed of many blood sinuses lined by two or more rows of tumor-cells. Very delicate stroma." In the opinion of the latter it was an extremely malignant type of tumor.

This patient was treated with toxins alone (mixed toxins of erysipelas and bacillus prodigiosus). She proved very susceptible, her temperature on one occasion rising to 108° F. In Doctor Coley's opinion the remarkable feature of this case was that under only eleven injections all evidence of the disease disappeared, and the patient was in excellent health when presented by Doctor Lihenthal three years later. She was still well when presented by Doctor Coley at the Memorial Hospital conference December, 1932, and is still well.

Doctor Coley said, that the first case that had aroused his interest in the effect of erysipelas upon malignant tumors was one of recurrent lymphosarcoma of the neck in which Dr. William T. Bull, after attempting a fourth operation in 1884, found the disease had so extensively involved the deeper structures of the neck that he abandoned the operation, closed the wound, and regarded the condition as hopeless. The patient developed a severe attack of erysipelas in the wound immediately after the operation, and ten days later a second attack occurred. On coming across the history of this patient in 1890, while making a study of all the cases of sarcoma observed at the New York Hospital over a period of fifteen years Doctor Coley was so impressed with the remarkable result that he made an effort to learn how long the patient had survived. He finally was able to trace the latter, and found him in excellent health, without any trace of the tumor, six years later.

This result led Doctor Coley to try the effect of the living streptococcus of erysipelas on a group of inoperable tumors. The first case which he inoculated in 1891 was one of far-advanced inoperable sarcoma of the tonsil and neck, the patient made a good recovery and remained well for eight years when he had a recurrence which proved fatal. Since then Doctor Coley has had an opportunity of using the toxins in a large number of cases of lymphosarcoma and Hodgkin's disease.

While Doctor Coley believes that the present trend in the treatment of these cases is toward irradiation, he pointed out that those who have had a large experience with irradiation in this type of tumor admit that the treatment is only palliative and practically never yields a permanent cure. Desjardins and Foid, of The Mayo Clinic (J A M A, p. 925, September 15, 1923), in 1923 stated that the only form of treatment that exercised noteworthy influence on lymphosarcoma was irradiation, and in a later paper (J A M A, October 8, 1932) Desjardins stated that a "permanent cure of lymphosarcoma by any method of treatment was unknown." In view of these statements Doctor Coley called attention to his report of 1928, made before the American Surgical Association (ANNALS OF SURGERY, October, 1928), covering 264 cases of lymphosarcoma and Hodgkin's disease in which he reported twenty-one five-year cures, lymphosarcoma (eighteen), Hodg-

kin's disease (three) In every case but one there was a microscopical confirmation of the diagnosis The toxins alone had been used in sixteen cases, the toxins and irradiation in four, and one case was treated with the living cultures of erysipelas Three of the patients had remained well for more than twenty years, and eleven, from ten to twenty years

In view of these results in a condition admittedly hopeless as regards a permanent cure by either irradiation or surgery, the question naturally arises, Why are the toxins not more widely used at present? Doctor Coley believes one reason may be that lymphosarcoma is such a rare disease that the ordinary surgeon sees only an occasional case, too few to permit him to test the various methods of treatment Second, most of the cases are sent to the larger hospitals where only two methods are generally employed, *i e.*, surgery and irradiation A third reason, and, in Doctor Coley's opinion perhaps the most important, is that a relatively much greater amount of time and personal supervision on the part of the attending surgeon is required for the administration of the toxins

OBSERVATIONS ON DISABILITIES FOLLOWING TRAUMA OF THE EXTREMITIES

DR DONALD GORDON read a paper with the above title

DR GORDON illustrated his paper by the following case An Italian housewife, aged sixty-one, applied to the Out-Patient Department of the Fifth Avenue Hospital, August 29, 1933, complaining of pain in the left wrist and bleeding from face and forehead A short time before admission, she had stumbled while going downstairs, and fell several steps She did not lose consciousness and walked to a drug store, where the druggist referred her to the hospital On examination she was found to have contused abrasions of the left cheek and forehead with ecchymosis of the left lower eyelid, hæmorrhage from nose, and a possible fracture of the left radius A temporary splint was applied to the left forearm and hand Suitable treatment was given for the abrasions and an X-ray made immediately She was examined by an attending surgeon, who, after viewing the films, considered that a reduction was not indicated He advised that anteroposterior molded plaster splints be applied, which was done by the interne She was told to keep her arm elevated, and to return to the clinic the following day, which she did

Her record shows August 30—Examined, comfortable September 11—Twelve days later, splint O K, bandage loosened September 20—Two weeks later, posterior splint removed, and daily hot soaks ordered October 4—Two weeks after last visit, same treatment October 11—Forty-one days or about six weeks after injury, she was seen by Doctor Gordon for the first time when she returned for physiotherapy The anterior splint was still being used, as the hand and wrist were swollen and painful There was pitting of the soft parts on pressure There was a bony deformity at the lower end of the radius suggesting posterior displacement of the distal fragment or non-reduction of the original displacement The metacarpophalangeal and the interphalangeal joints were stiff, movements were limited by pain in these joints and wrist Active and passive movements

showed wrist flexion 10° , extension 5° , adduction and abduction about 10° , supination 0. Metacarpophalangeal joints, flexion 45° , proximal interphalangeal joints 45° , distal interphalangeal joints 15° .

Exceeding the degrees of movements as above gave pain in the joint moved, and not any other, nor was there any referred pain to the region of the tendon sheaths suggesting tendon involvement. The tendons did not appear to be the cause of the pain, nor the lost degrees of motion, as tendon action which permitted 45° flexion of proximal joints should have permitted more than 15° in the distal joints activated by the same tendons. A second X-ray was taken.

The X-ray report of the original film taken August 29 was "Colles' fracture of left wrist. The fragments are in good position."

The report on the films made October 11 was "films of the left wrist show union of fracture of radius. The articular surface shows a slight tilt toward the dorsal surface of forearm not present previously. Styloid of ulna has failed to unite. Though no mention is made of decalcification, lantern slides show this change also."

The case is shown as an example of stiff fingers following a simple fracture of the lower end of radius and styloid of ulna with delayed secondary displacement of the radial fragment. The stiff fingers are due, he believed, to what he termed post-traumatic peri-articular fibrosis.

The picture presented is one of loss of function of joints, following persistent swelling caused by a simple fracture proximal to the joints involved, and augmented by the displacement. In this particular case he believed the swelling could have been avoided sufficiently to have prevented to a large degree the present existing process by the following:

(1) Greater assurance that the arm was adequately elevated to avoid swelling and permit finger movement.

(2) More loosely applied dressings.

(3) Application of a type of retention dressing with the wrist in flexion, which would have prevented the tilting of the distal fragment backward, though the position used and type of dressing is one most commonly seen.

(4) Early recognition of the secondary displacement which augmented the distal swelling and its correction.

(5) The recognition of the fact that the persistent swelling was a symptom of some complication, which called for investigation and correction.

(6) Seeing the case more frequently than was recorded and seeking for the cause of the symptoms presenting.

Dr H. H. M. LYLE remarked that the loss of function of any part is directly proportional to the destruction of tissue, the degree of infection and the length of time that elapses before the part is put to functional use. If, in addition, the vasomotor mechanism is separated from the central nervous system due to damage or pressure of dense scar tissue, a local excess of activity takes place in the peripheral part and we get dilatation of the vessels, a thickening of the joints with extra intra-articular contractures and articular fibrosis. In the trauma of fractures we can get this phenomenon of interruption of vasomotor impulses with the resulting oedema, *etc.* Certain fracture cases, although well treated, develop the syndrome described by Doctor Gordon. Why this occurs in some cases and not in others is hard to say, yet we suspect that there is a neurogenic element or rather

a neurovascular element underlying it. In our experience these cases occur more often in women past middle age. They suffer a mild Colles' fracture are apparently well treated, yet we get œdema, bony atrophy and a stiff wrist. Doctor Gordon's paper rightly emphasizes the old dictum that there is a best position for every joint and every injury and this position, in the majority of cases, is the physiological position of rest.

DR KIRBY DWIGHT said that this condition has bothered more young surgeons than almost any other. His own introduction to a hand of this type was as a junior in the hospital on the ambulance staff. The first fracture case he had was that of a woman of forty years of age with a simple Colles', but the hand turned out to be like the one that Doctor Gordon has shown. Later, working in the dispensary with Doctor Gordon, the speaker saw a great many more of them but they could not determine any etiology for it. They could not predict in what case that result might appear. All they knew was that it followed some kind of injury or infection, if an injury, it had to be severe, it did not occur in people below the fifth decade of life and four out of five of the patients would be women. Some of the cases came in for the first time two or three weeks after the injury without having been treated, so it was not due to splintings. In some cases there was a suspicion that it had something to do with the amount of swelling, but it was impossible to predict this condition by the presence or absence of swelling. Doctor Dwight had called it "glossy hand" and had had no idea of the pathology. But the morbid changes go all through the tissues of the hand. It is not a true arthritis, because there is no pain within the limits of easy motion of the joints. The skin shows atrophic changes. The nearest approach to the etiology was that which Doctor Lyle had suggested. Due to widespread atrophy of bone and skin there must be some atrophic process of neurogenic origin. This class of case should be made a clinical entity, understood by everyone. It is a comfort for a surgeon to know that the bad result which he gets is not caused by his failure to give the patient proper treatment.

DOCTOR GORDON, in closing the discussion, said that he thought this condition should be presented in such a way that it would be generally understood, as he believed it could be prevented in many instances.

In reference to Doctor Lyle's mention of the possibility of a neurological factor entering into this condition, the speaker cited a case which he took care of last winter, where the median nerve had been stretched over a displaced semilunar bone for three months, causing a great deal of swelling of the hand. Before operating upon him, Doctor Gordon was apprehensive of the onset of this peri-articular fibrosis, but it did not develop, probably due to the use of efficient elevation to avoid post-operative swelling.

As to the neurogenic theory, Fontain and Herman, from the LeRiche's Clinic, have stated that they had relieved post-traumatic osteoporosis by means of peri-arterial sympathectomy and ganglionectomy, but Doctor Gor-

THE RECONSTRUCTION OF THE COMMON BILE-DUCT

don doubted that they had restored function as quickly as was claimed. Regarding the unreduced fracture, it will tend to produce swelling, and the first thing to do is to get an early reduction to as satisfactory a position as possible. As to the extension of the splint beyond the metacarpophalangeal joints, the speaker always used non-padded split plaster dressings which afford greater ease for the relief of pressure without danger of displacement, and facilitate motion of the parts requiring movement by not extending beyond the metacarpophalangeal joints. If the fracture is adequately immobilized, this will give greater mobility to the parts which should be mobilized, provided swelling is prevented by elevation. The plaster splint carried to the ends of the fingers and preventing movement of these is a real factor in producing this condition.

THE RECONSTRUCTION OF THE COMMON BILE-DUCT

DR THOMAS H. RUSSELL presented a woman, aged forty-two, whom he saw first January 20, 1931. She had been operated upon two days before for chronic adhesive cholecystitis and appendicitis. The gall-bladder and appendix were removed. At this time she was nauseated, the abdomen was moderately distended, her temperature was 101° , pulse 100, and there was a moderate degree of jaundice which was more marked in the sclera. The urine was port wine color. The blood was immediately examined for determination of the icterus index, which was found to be 55. The possibility of an injury to the common bile-duct suggested itself and immediate exploration of the duct was advised. At five o'clock that afternoon Doctor Russell opened the wound in the upper abdomen, which was done by simply removing all sutures of the abdominal wall. The common duct was easily found and the first ligature seen, which had been cut long, was found encircling the common bile-duct just above the point of junction of the cystic duct. There was also a ligature around the cystic duct just distal to the point where it had been cut in the performance of the cholecystectomy. The common bile-duct was gangrenous about the ligature encircling it. He removed the ligature and after making a longitudinal incision in the duct inserted a "T" tube. A cigarette drain was placed down to the foramen of Winslow and the wound closed in layers with plain catgut, and the skin with silk. The patient made an uneventful recovery. The icteric index was 30 the next day, and was 17 two days later. On the twenty-first post-operative day the "T" tube slipped out, and bile drained from the abdominal wound. The patient insisted upon going home February 28, four weeks from the day of the second operation.

Four days later, March 4, 1931, she was admitted to St. Francis Hospital, stating that the wound was continuing to discharge large quantities of bile, and that she was troubled with much abdominal distress after meals. Her stools were formed and of natural color. After a few days' rest in the hospital she felt better, until March 16, when there appeared to be slight jaundice, the icteric index was eleven. In a few days the jaundice disappeared and she felt well again. March 31, she was decidedly jaundiced and the icteric index was forty.

April 4, two months after the first operation, he reopened the abdomen, incising the old scar in the upper abdomen, and exposed the common duct. He found a stenosis of the duct at the site of the old trouble about one inch in length. This stenotic part of the duct was excised and an effort made

to bring the two ends of the duct together over a "T" tube, but he was unable to get accurate apposition of the ends, hence the chance of a recurrence of the stricture at this site was most probable.

Reports of various operations designed to establish a fistula to later anastomose into the stomach have heretofore been so unsatisfactory in a large percentage of cases that he adopted a different procedure, bringing the long piece of the "T" tube up along the posterior wall of the stomach just proximal to the pylorus, sewing a piece of the gastrohepatic omentum about the tube so as to fix it to the stomach wall with the idea of having a sinus form along the stomach wall to later open into the stomach. This was accomplished very easily. The abdominal wound was again closed around the tube and a cigarette drain, which drain was removed on the third post-operative day. Bile drained from the abdomen around the "T" tube for several days, then ceased. In a few days the "T" tube was pinched off with a Murphy-drop clamp for several hours a day until finally the patient was taught to unpinch the clamp for a few minutes night and morning, and to keep the tube in position by means of adhesive strips.

The patient was discharged from the hospital May 2, 1931. She returned every few weeks for examination until October 20, 1931, when she was readmitted for the final operation. She had gained in weight and stated she felt well and had been doing her usual household duties.

On October 23, 1931, the icteric index was ten. On October 26, almost seven months from the time the tube had been inserted, the sinus around the tube was dissected free down to where the tube was fastened to the posterior wall of the stomach. A two-inch incision was made through the anterior wall of the pyloric end of the stomach parallel to its long axis, then a stab wound made through the posterior wall of the stomach into the sinus containing the tube. Several inches of the long end of the tube were cut off and the tube pulled through into the stomach. The tube was then cut off flush with the inner surface of the stomach, but was not removed as the tube had been retained with so much difficulty that he thought it would soon be discharged into the stomach. The anterior wall of the stomach was closed transverse to its long axis to avoid narrowing of the stomach at this point. The excess sinus was cut off and the end sutured. The abdomen was closed without a drain. The patient made an uneventful recovery. November 12, 1931, a flat X-ray of the abdomen showed the tube still in position. The patient left the hospital November 14 and has returned monthly for X-ray. The last one, taken February 2, 1932, showed the tube still in position. She is now feeling well and doing her regular work. All the above operations were done with spinal anaesthesia using two cubic centimetres of spinocaine.

August 3, 1932, nine months after the last operation and sixteen months after the tube had been inserted, this patient returned complaining of a ventral hernia. The herniation which presented itself was weakness along the lower end of the scar, which was really not a bad hernia but I grasped this opportunity to remove the tube which X-ray showed still present between the common duct and the stomach. August 10, 1932, with spinocaine anaesthesia, the old scar was excised. The anterior wall of the stomach opened parallel to its long axis. The tube which was presenting itself through the posterior wall of the stomach was grasped with a hæmostat and removed.

Bile was flowing freely through the new opening. The anterior wall of the stomach was closed transversely to the line of incision and the hernia repaired without drainage.

THE RECONSTRUCTION OF THE COMMON BILE-DUCT

The patient has remained well except for occasional gas, and has gained thirty pounds in weight since the last operation fourteen months ago

DR CHAS GORDON HEYD stated that there had been developed a large literature on injuries and reconstructive surgery of the common bile-duct. It was unfortunate, however, that all these data were purely along the lines of experimental operations on animals or even on the cadaver. It was noteworthy that in a field of brilliant surgery and expert operators there were relatively so few successful cases of actual reconstruction of the common duct. The great majority of injuries to the common duct had their origin in operative accidents and most of the injuries to the common duct were not recognized at the time of operation but became manifest at varying intervals of time after operation. It was well to remember that there were two particular classifications in which plastic or reconstructive operations were indicated. The first group were the cases in which the gall-bladder was removed and there developed an impassable stenosis of the common duct, and the development of chronic jaundice. In this group of cases nature availed herself of the tremendous distention power of the common duct. The biliary ducts—common or hepatic—above the obstruction became greatly distended or dilated. It was in this type of case that the various operations for the anastomosis of the proximal portions of the duct to either the stomach, duodenum or intestine were possible. Mayo, in 1905, united the hepaticus to the duodenum and the functional result was excellent. Where this technic is possible the result will be, by and large, uniformly good. The second great group of cases are those in which the gall-bladder is absent, there is an impassable stenosis of the common duct and the presence of a persistent, external, biliary fistula. In this type of case the common duct below the stenosis is ordinarily of normal size and the common duct or hepatic duct above the stenosis is usually normal, but the removal of the stenotic portion brings into being a defect in continuity that cannot be abridged by end-to-end anastomosis or any of the plastic types of operation on the common duct. Surgical correction depends upon the ingenuity of the surgeon, for he must utilize some indirect method to accomplish continuity of the common duct and adequate biliary drainage. The condition of these patients is indeed horrible. The operative risk is great and the technical difficulties in many cases seem almost insurmountable. Doctor Russell's case presented a graded series of operative steps and there is every reason to believe that to-day, nineteen months after his reconstructive surgery, the patient is, to all intents and purposes, cured. The introduction of the "T" tube and carrying the long arm of the "T" tube across the posterior surface of the stomach and covering the "T" tube with omentum created a most admirable external biliary fistula. The simplicity with which this external biliary fistula was turned into the stomach was most praiseworthy. The final step in recovering his tube completed a very cleverly thought-out plan of graded steps for the correction of the condition.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD MARCH 6, 1933

The President, DR JOHN SPEESE, in the Chair

CALVIN M SMYTH, JR, M D, Recorder

TOTAL GASTRECTOMY FOR CARCINOMA OF THE STOMACH

DR JOHN B FLICK reported the case history of a man, aged fifty-five, born in Italy, who was admitted to Jefferson Hospital December 19, 1930, complaining of epigastric distress, vomiting and loss of weight and strength. The symptoms began in July, 1929. At first vomiting occurred several times a week and then daily. The vomitus contained food which he had taken at his last meal. There was never, to his knowledge, any blood in it. He had lost thirty pounds in weight in six months. He had discomfort after meals, but no definite pain. The discomfort was relieved by vomiting. He had always been healthy until the onset of this illness, except for an ischio-rectal abscess which was drained in 1905 and some "heartburn" in 1918 which soon disappeared. He had used alcoholic beverages and tobacco in moderation. On admission the patient appeared somewhat emaciated. His abdomen was scaphoid. The edge of the liver could be felt but there was no mass palpable and there was no tenderness. The blood Wassermann reaction was negative, haemoglobin, 78 per cent, red blood-cells, 4,250,000, white blood-cells 6,000, and blood-pressure 108 systolic and 66 diastolic. Temperature and pulse were normal. The non-protein nitrogen, creatinin and sugar of the blood were within normal limits. The urine was negative. An X-ray examination showed what was thought to be a carcinoma involving the pars media and extending to the pyloric end of the stomach.

December 26, 1930, upon operation, the stomach was found to be small, its walls were thickened and there was marked induration of the pars media and pyloric end. It seemed to be almost completely involved in a carcinoma of the linitis plastica type. There were some enlarged lymph-nodes along both curvatures close to the stomach. There was no gross evidence of involvement of the liver or other viscera. It was obvious that no part of the stomach was sufficiently free of disease to permit of a gastrojejunostomy and a total gastrectomy was, therefore, decided upon. The duodenum was divided between clamps, but fearing that the division had been too close to the pylorus, a second clamp was placed behind the first and an additional section of duodenum removed. The stomach was freed from its omental attachments, taking with it the enlarged lymph-glands, several of which were along the coronary artery. The latter artery was doubly ligated with No 2 chromic catgut proximal to the enlarged glands and divided. The stomach was then turned up and used as a tractor to expose the abdominal oesophagus. A loop of the jejunum was brought through the mesocolon and approximated to the oesophagus with five interrupted sutures of linen thread. An oesophagojejunostomy was done using two rows of continuous sutures of No 0 chromic catgut. The stomach was not cut away until the inner suture layer was almost complete. No clamps were used. The jejunum on either

ABDOMINAL ACTINOMYCOSIS

side of the anastomosis was fastened to the diaphragm to relieve the strain on the anastomosis. The margins of the opening in the mesocolon were sutured to the jejunum with a few interrupted sutures and the abdomen closed. The operation was a long one and the patient was in a state of shock at its termination. He was given normal salt solution by hypodermoclysis, intravenous infusion of glucose and later a transfusion of 240 cubic centimetres of blood. He reacted from the shock, but developed almost complete suppression of urine and died on the third post-operative day.

Forty-eight hours after operation his blood non-protein nitrogen was 60.6 and creatinin 9.44. Before death there was great restlessness, muscular twitchings and his temperature rose to 106.8° F. There was no vomiting nor any indication of peritonitis. Permission for autopsy could not be obtained. The laboratory report upon the specimen removed was Diffuse carcinoma of the stomach (leather bottle type). *Limitis plastica*.

ABDOMINAL ACTINOMYCOSIS

DR JOHN H. GIBBON, JR., by invitation, reported the case history of a Negro male, twenty-four years of age, who was admitted to Pennsylvania Hospital in the service of Dr. Charles F. Mitchell, March 14, 1932. Three days prior to admission he had taken Epsom salts and the following day developed pain in the right lower quadrant of his abdomen. He was nauseated but did not vomit. Physical examination was negative except for marked rigidity and tenderness in the right lower quadrant of the abdomen. His temperature was 99.6° F., pulse, 84, white blood-cells, 20,400 per cubic centimetre, urine, negative.

Under spinal anaesthesia, the abdomen was opened through a right lower rectus sheath incision. There was no free fluid in the peritoneal cavity. A mass surrounded by omentum was palpated in the region of the caecum. The appendix was markedly swollen and covered with a fibrinous haemorrhagic exudate. Examination showed a small perforation at its middle from which pus exuded. The appendix was removed and the stump inverted. The wall of the caecum was not thickened and appeared normal. Two rubber-covered gauze drains were inserted and the abdomen closed. There was a slight febrile reaction following operation, but the temperature was normal on the seventh day when the drains were removed. He was discharged from the hospital twenty days after operation with a small draining sinus from which protruded exuberent granulation tissue. The blood Wassermann reaction was strongly positive and anti-luetic treatment with mercury and iodides was started prior to his discharge from the hospital. A small superficial ulcer over the lower third of his left tibia was dressed with mercurial ointment. The patient was uncooperative, and returned at long and irregular intervals for the anti-luetic therapy and the dressing of his wound and ulcer of the leg. He was not seen from May 13 to August 5, when he returned to the hospital because of fever and a marked purulent discharge from his abdominal sinus. He said that his abdominal wound had never healed, and that the discharge had increased during the last two weeks in July. August 7, a superficial fluctuating mass near the old abdominal sinus was incised and pus evacuated. The blood Wassermann reaction was still strongly positive, and mercury and iodides were given.

The continued discharge from the abdominal wound was thought to be due to his untreated luetic infection, but the possibility of actinomycosis was suggested. A smear of the pus from the abdominal wound on August 17

showed many cocci and bacilli, but no ray fungi. There was no growth of the culture in six days.

August 26, another large fluctuating mass above the right iliac crest was widely incised under nitrous-oxide oxygen anæsthesia. The abscess cavity lay between the skin and the abdominal muscles. It was multilocular but the partitions could easily be broken down with the finger. A large quantity of pus and debris was evacuated. No connection with the original sinus of the anterior abdominal wall could be discovered. The original sinus was widely opened and both cavities were packed with iodoform gauze. Actinomycotic granules were now found in the pus at the time of operation and typical ray fungi were seen under the microscope. Microscopical examination of the tissue from the abscess wall showed colonies of actinomycetes (Fig 1).



FIG 1

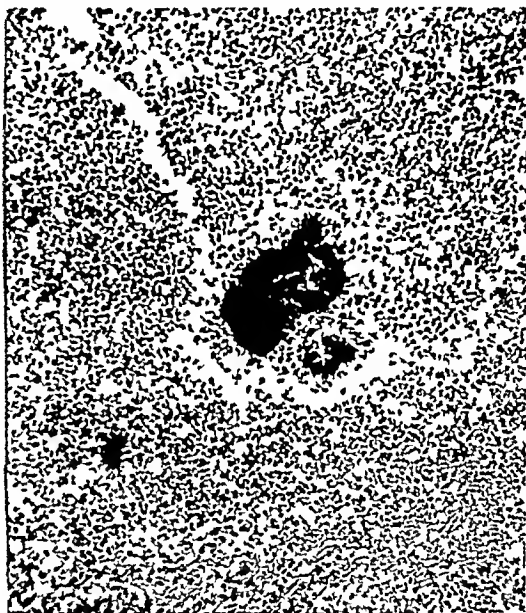


FIG 2

FIG 1—Photomicrograph ($\times 175$) of tissue removed from the wall of the abscess in the right flank August 26, 1932. The bacterial stain used shows the Gram positive filaments of the actinomycetes in a dense interlacing network in the colony.

FIG 2—Photomicrograph ($\times 175$) of tissue at the border of the hepatic abscess. There is a large dense colony of the ray fungus at the centre and two smaller ones nearby. No normal hepatic tissue is shown.

Following operation, the daily dose of potassium iodide was rapidly increased to 140 grams. The iodoform gauze packing was removed on the second post-operative day. Carrel tubes were inserted and the abscess cavities irrigated with one-third strength Lugol's solution every second hour during the day and every third hour at night.

X-ray examination of the chest September 1 showed no involvement of the lungs, ribs or thoracic spine. Repeated urine examinations were negative. The patient was anæmic. Hæmoglobin, 53 per cent, red blood-cells, 2,890,000, and white blood-cells, 29,700. The differential count was normal with 76 per cent polymorphonuclear neutrophils. From the time of admission the patient's temperature had varied between 99° and 102° F. As there was no abatement of fever following the last operation it was thought that surgical drainage was inadequate. September 2, under gas-oxygen anæsthesia, an incision was made from the lateral border of the right lower rectus sheath to the lumbar triangle of Petit, connecting the two suppurating abdominal wounds. This necessitated dividing all the abdominal muscles

attached to the crest of the ileum, thus producing one large, widely opened cavity. The cavity was extended up along the lateral and posterior wall of the cæcum and ascending colon, and down as far as Poupart's ligament. Bleeding from the friable necrotic tissues lining the abscess cavity was controlled by packing with iodoform gauze. A blood transfusion of 500 cubic centimetres was given by the direct method the following morning. Two days after operation the iodoform packing was removed, and the wound loosely filled with gauze. The gauze was changed daily and was saturated with Lugol's solution every second hour during the day and every third hour during the night. Potassium iodide was increased to 180 grains a day.

Two weeks after operation the patient's temperature, which had been normal for six days, began to rise again. An X-ray treatment was given, but was followed by such a severe systemic reaction that it was not repeated. The wound filled in with granulation tissue, but sinuses developed in the posterior portion, and despite continuous irrigation with Lugol's solution through catheters, several more abscess cavities developed in the lumbar region and over the buttocks. These were opened and drained. The patient gradually became more emaciated and weaker and the hectic temperature continued. The anæmia persisted, but did not become more marked. There were never any symptoms of pulmonary involvement. The patient became comatose on January 26, 1933, and died a few hours later.

At autopsy there was some serious effusion in the pericardium and pleural cavities and congestion of the bases of the lungs, but no gross evidence of disease of the thoracic organs. There was a small amount of clear straw-colored fluid in the peritoneal cavity. The peritoneum was smooth and glistening. The omentum was slightly adherent to the cæcum and to the abdominal wall at the site of the appendectomy scar. There were no other intraperitoneal adhesions. The edge of the liver extended just below the costal margin. There was general enlargement of the mesenteric lymph-nodes, but no evident disease of the large or small bowel. The sinus tracts in the right lower quadrant of the abdomen were found to extend into the retroperitoneal tissues about the right kidney, and to involve the right psoas muscle. The vertebral discs and the bodies of the second to the fifth vertebrae, inclusive, showed some softening. The tracts extended over the sacral promontory into the left psoas muscle. The more extensive involvement, however, was on the right side of the spinal column. There were areas of necrosis throughout the right psoas muscle and there was some roughening of the right twelfth rib. Posteriorly, the sinuses followed the fascia planes from beneath the twelfth rib to the lumbar region, where drainage had been instituted.

The liver was the only organ showing gross involvement by the actinomycetes. A large abscess was found in the central portion of the liver substance near the gall-bladder and the left lobe. The abscess was eight centimetres in diameter and filled with creamy pus. No sulphur granules were seen and smears showed bacilli but no fungi. There was no growth on culture. Microscopical examination of the abscess wall in the liver showed colonies of the ray fungus (Fig 2). Ray fungi were seen in the lungs on microscopical examination. The mesenteric lymph-nodes showed only the histological changes incident to inflammation.

Doctor Gibbon remarked that actinomycosis is not a rare disease in this country. In 1925, Sanford and Voelke¹ reviewed 670 cases reported in

the United States Eighteen per cent were abdominal Good,² in 1931, reported sixty-two cases from The Mayo Clinic in which the disease was primary in the abdomen, and in only eight of these cases was the disease arrested The origin of the infection in the case reported here is not clear There was no evidence of involvement of the mouth, neck or respiratory tract The cæcum was apparently normal at the time of the appendectomy Gross dissection of the appendix, and repeated microscopical examinations, failed to reveal the presence of any actinomycetes

Cure or arrest of the disease lies in early and energetic treatment The failure in this case may be ascribed to the delay in establishing the diagnosis Probably the sinuses should have been widely opened as soon as they appeared, but the patient's failure to respond to the extensive and almost mutilating incision of his abdominal wall deterred further surgical efforts It is difficult to estimate the effect of X-ray and radium therapy upon the disease as they have practically always been used in conjunction with other methods of treatment in the arrested or cured cases which have been reported Probably in this case intensive X-ray therapy should have been used after the anæmia had been controlled

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² Good, L. P. Actinomycosis of the Abdomen Arch Surg, vol 44, p 307, February, 1931

DR RICHARD H. MEADE said that for five years he had been following a patient with this disease He started off with an infection of the jaw which cleared up after extraction of a tooth Some weeks later he developed pneumonia, then empyema He was operated upon for empyema and in a few months developed chest-wall and abdominal-wall abscesses, none of which showed the causative agent He had diabetes in addition About four months after the empyema was drained, typical sulphur granules were obtained from all wounds This man had treatment by iodine and X-ray as well as by surgery and after being in the hospital fourteen months returned home with several draining sinuses, apparently to die Three months after returning home, without any special therapy whatever, all the drainage stopped and he was free from all evidence of disease for twenty-three months At that time he returned for study with some evidence of lung involvement He has now continued another year in comparative health and requires no treatment except for the diabetes We are at a complete loss in this case to give credit to any single form of therapy Doctor Wangenstein reported a case last year successfully treated by surgery alone and there are several other reports indicating that surgery offers the best outlook, rather than X-ray and iodine



Fig 3

Fig 4

Fig 5

Fig 3—Barium enema May 8, 1931, showing polypoid filling defect in sigmoid colon.

Fig 4—Barium enema June 19, 1931, one month after transverse colectomy. No change in appearance of bowel.

Fig 5—Barium enema November 7, 1932. No further bowel symptoms, but marked contraction of the bowel lumen may be seen with disappearance of the vacuolization due to the polyp.

ULCERATIVE COLITIS

DR L F FERGUSON presented a woman, thirty years of age, who had an attack of what was called intestinal influenza in 1927 at which time she suffered from a bloody diarrhoea. She was confined to a hospital for a period of six weeks. The bleeding and frequency of movements decreased somewhat but returned in attacks and in January, 1931, her physician recommended extraction of her teeth. She rapidly lost weight and strength following this operation, complained of marked abdominal pains and had such frequent bloody bowel movements that she was unable to leave her home. When first seen April 4, 1931, she had such marked prostration that she was continually dizzy and could barely walk. She was having from ten to fifteen bowel movements per day, all of which contained much pus and blood. Her hæmoglobin was 35 per cent and her red-cell count about 2,000,000. Following three transfusions she improved markedly. Proctoscopical examination May 4, 1931, showed an extensive ulceration of the rectum and lower bowel with marked bleeding. At a point about ten centimetres from the anal orifice, several polyps were noted between the ulcerations. The lumen of the bowel was about two centimetres in diameter. A barium enema (Fig 3) showed a loss of haustrations extending to the middle of the transverse colon with areas of polyposis throughout the involved portions. Because of the marked constrictions of the lumen of the gut, the patient was advised to have a colostomy performed. This operation was done May 16, 1931, in the Philadelphia General Hospital in the service of Dr E L Eliason. The abdomen was opened through a lower right rectus incision under spinal anaesthesia. The large gut from the middle of the transverse colon downward was tubular in shape, thick and about two to three centimetres in diameter. Proximal to this point the gut was normal in appearance. A right gridiron incision was then made and the middle portion of the transverse colon delivered to form a loop colostomy. Two further transfusions were given before the patient was discharged from the hospital. At the time of her discharge her red-cell count was 3,620,000 and the hæmoglobin 70 per cent.

Just before her discharge from the hospital a barium enema (Fig 4) showed an X-ray picture essentially the same as before the operation.

The patient has been seen at frequent intervals since leaving the hospital. She has gained weight and is now able to live a normal life. Usually she has two bowel movements per day and wears a colostomy bag only for protection. She has been receiving autogenous vaccines of hemolytic streptococcus equi and non-hemolytic staphylococcus albus.

Proctoscopical examinations now show an almost complete healing of the ulcers of the bowel but the lumen of the gut is so contracted that only a very small proctoscope can be passed. Because of the extensive polyposis the question was raised as to whether malignant degeneration should be looked for and for this reason a third barium enema examination (Fig 5) was made in November, 1932. The marked constriction of the bowel is easily noted but the outline of the gut is smooth and the previously observed polyps seem to have largely disappeared.

The speaker added that proctologists and gastroenterologists hailed the work of Baigen as a new epoch in the treatment of chronic ulcerative colitis. This discouraging disease which has resisted therapeutic efforts seemed to have succumbed to rational methods of treatment when a causative

organism was found by means of which immunizing vaccines or sera could be prepared. Unfortunately, Bargaen's work has not been universally duplicated, but the use of autogenous vaccines has proved beneficial in many cases. Their experience in the Proctology Clinic at the University of Pennsylvania Hospital has been that relatively few cases of ulcerative colitis will show the Bargaen diplococcus, although his culture media have been used and his technic closely followed. They have, however, been able to isolate many types of streptococci from cultures made directly from the ulcer at proctoscopic examination, and administration of vaccines prepared from these cultures has given excellent results in many of these cases.

Vaccine therapy is of particular value if the patient is seen during the early stages of the disease. In the later stages there are marked inflammatory changes with stricture formation and often inflammatory polyposis. In this stage vaccine or other conservative therapy is rarely successful and the patients continue semi-invalids, often unable to leave their homes because of the necessity for frequent bowel movements. In such cases operative intervention may often enable the patient to live a normal life.

The operations which have been proposed for the treatment of ulcerative colitis may be divided into two groups. The first group, ileostomy and appendicostomy, are often used in the active stage of the disease. Regan and Mensing employ ileostomy as a means of producing physiological rest during the acute stage, with later anastomosis after the disease subsides. Appendicostomy has been used to make possible irrigation of the diseased bowel. The success of these procedures has not been great, and it is certain that conservative therapy has given as good results.

The second type of operation is used in the late stages of the disease, when contracture of the bowel wall is a constant feature. Permanent drainage of the gut above the affected area is the indicated surgical procedure. The site of the drainage must be determined by the extent of the bowel involvement as shown by barium enema. When the entire colon is involved, ileostomy is the indicated operation, when only part of the large gut is diseased, a colostomy proximal to the diseased area should be performed. Colostomy with resection of the involved colon is an extensive operation, rarely indicated to effect a cure.

Doctor Ferguson, in closing, said that he would like to have some opinion expressed as to whether or not colectomy should have been performed in view of the widespread polyposis. The patient was in such poor condition that he did not wish to subject her to such extensive surgery. Is it possible in these cases that drainage of the bowel will suffice?

DR CALVIN M. SMYTH, JR., said that it is generally conceded that polyposis is the one lesion of the large bowel that is definitely pre-cancerous. In many cases of diffuse polyposis a painstaking microscopical examination will show that malignant degeneration has begun to take place in one or more of

the polyps It is conceivable that an operation such as the one described by Doctor Ferguson upon this patient might result in a cure of the colitis, although the speaker wondered just how Doctor Ferguson arrived at the conclusion that the involvement of the colon was limited to such a restricted area This is not the usual case in ulcerative colitis and it would, therefore, seem that ileostomy, which excludes the entire colon, would be a more logical procedure It is evident that simple drainage has in a large measure relieved the symptoms attributable to colitis in this patient, but is it possible to state from the X-ray appearance alone that the polyposis has cleared up? The speaker believed that, as a general rule, the interests of the patient in cases of this type are best served by a preliminary ileostomy followed by colectomy and restoration of continuity at a later date It is, of course, necessary to allow a sufficient interval between the two operations By thus staging the surgery a poor or indifferent risk may often be converted into a good risk and the patient thereby be given the benefits of complete surgery

PILONIDAL CYSTS

DR S DANA WEEEDER read a paper with the above title for which see page 385, vol 98, September, 1933, ANNALS OF SURGERY

DR HUBLEY R OWEN remarked that the terms pilonidal cyst, sacral dermoid, sacrococcygeal cysts, and piliferous dermoids are somewhat erroneous inasmuch as a true cystic condition is decidedly rare We find that the same condition, not often it is true, in the anterior raphe or line of fusion elsewhere A similar condition under the hyoid bone was reported by Massé, in 1887 This patient had the same pathological entity in the sacrococcygeal region In another patient the cyst was found over the sternum In one of the speaker's cases the tumor extended as high as the lumbar region

The term "pilonidal" is derived from the Latin composed of "pilus" for hair and "nidus" for nest or focus The implication of this term can be only one of two states, that is, it is either a sinus or a cyst having hair as its focus Neither of these conditions is true always Lawson Tait and many others consider the condition to be a persistent remains of neurenteric canal Fere believes it to be caused by failure of two halves of the body to properly unite behind, while others believe it to be due to an invagination or retraction of the skin with a subsequent partial degeneration, and as recently as July, 1931, Stone, of Baltimore, advanced the imaginative theory that it might be traceable to an evolutionary persistence of the Avian preen gland from which the bird obtains oil with its beak pressing down its feathers Doctor Owen suggested the term raphe inclusions because of the fact that these inclusions occur in the seam of the body or mid-line, not only in the sacral and sacrococcygeal region, but also, as noted above, in the region of the hyoid, the sacrum and lumbar vertebræ The histories of a large number of cases occurring in three of the large hospitals in Philadelphia

PILONIDAL CYSTS

disclose certain salient facts (1) That less than 10 per cent occur in females In the speaker's series of thirty-one cases there was but one in the female (2) Practically every individual in the group was of the heavy or obese type—many of them classed as pituitary type In one case a note had been made of the peculiar sharp demarcation of the hair above and below the level of the sacro-iliac junction Below the hair was heavy, matted and tangled—almost ape-like, while above it was thin and of fine texture

Doctor Stone emphasized the fact in 1924 that not one had occurred in a member of the Negro race and in two of the hospitals whose histories were examined the Negro census equaled that and even surpassed the white census Furthermore, the condition appeared only in members of the Caucasian race Not one instance was found in a member of the black, red or yellow races This fact may be a coincidence It is also true of the histories examined whereas the clinical studies were not always complete, there was no positive Wassermann or Kahn reaction There are a few interesting questions which might be asked Why is it the condition does not manifest itself before adolescence and why is it apt to occur in the heavy obese type of person? Why does it occur so much more frequently in the male than in the female? Is it true that the majority of cases follow sedentary occupations? Does the sedentary occupation favor inflammatory change? Surely it is not because of laziness because it might then be more common in the Negro The Negro appears to be hereditarily free of this lesion yet the white man, accepted as an older evolutionary animal, has this condition far more frequently Is it because the white man's ability to fuse properly during his foetal life is becoming less or is it due to early species cleavage?

Doctor Owen presented an analysis of his cases as follows

SUMMARY OF THIRTY-ONE CASES OF DR H R OWEN

Males			30
Females			1
Oldest	45	Duration	18 years
Youngest	23	Duration	18 months
Average age			31.1 years

Duration of Symptoms

Average	14.6 years
Shortest	2 days
Longest	18 years

Chief Complaint

Discharge	13 cases	Hair found	7 cases
Pain	8 cases	Sinuses—largest number of sinuses	4
Both	5 cases	Single sinus	14
Cyst of spine	5 cases	Multiple sinuses	6

PHILADELPHIA ACADEMY OF SURGERY

<i>Post-Operative Length of Stay in Hospital</i>		<i>Post-Operative Temperature</i>	
Longest	27 days	Normal	15 cases
Shortest	3 days	Elevation	16 cases
Average	10 1 days		

Recurrence

Twenty-five cases have been followed for a period of over one year
 Two of thirty-one cases have had recurrence following reporter's operation
 Eight cases had been previously operated upon once
 One had had two previous operations
 One had had three previous operations

Type of Operation

Lahey	5 cases
Excision with central drainage of wound	6 cases
Excision with packing	20 cases

Anæsthesia

Complications

Gas	3 cases	Secondary hemorrhage	2 cases
Ether	6 cases	Upper respiratory infection	1 case
Local	1 case	Sacral teratoma undergoing sarco-	
Gas-ether	9 cases	matous degeneration	1 case
Spinal	12 cases		

DR GEORGE P MULLER said that during the past ten years, in the University Hospital, he had seen thirty-five of these cases, thirty-one were in men and four were in women (11 4 per cent)—a large percentage of women, according to most writers. One of these was a child of seventeen months. Omitting this patient the average age was twenty-six years. The condition is a very difficult one to treat owing to the long duration of the healing process and the frequency of recurrence. At the present time Doctor Muller is rather partial to the modified Lahey method in which only one lateral cut is made and the original incision sutured up.

DOCTOR WEEDEE, in closing, said that as to the terminology, he agreed "piloid" cyst was a bad term. As he has tried to show, the lining membranes of these cysts or sinus tracts will vary depending upon the time of inclusion of certain cells derived from the ectoderm. The early inclusions will be of completely potential cells in which case hair, sebum and sweat may accumulate in the cyst or be discharged from the sinus. Later inclusions would include impotential cells in which case stratified epithelium would line the wall or tract and there would be an absence of hair, sebum and sweat. A percentage of both types would have as part of their wall a remnant of the medullary canal which has remained unobliterated, in which case the cells would be a type of embryonal neuro-epithelium. It would seem, then, that a better term would describe first the location of these cysts or sinuses and secondly suggest their origin as being faulty develop-

CEREBELLAR ABSCESS

mental inclusions and obliteration of the medullary canal. These thoughts suggest the term sacrococcygeal medullary cysts or sinuses.

Most writers declare that the condition is found more commonly in the male than in the female. It happens, however, that in the four cases in which he has excised the coccyx there were three women and one man.

As to the time of appearance he believed this to be influenced by the incidence of injury. So often the patient gives the history of having fallen or injured the end of the spine. This injury seems to set up an inflammatory reaction.

Regarding treatment he has based it upon what appears to be the true etiology. A complete removal of the cyst or sinus wall will bring about a cure. If a percentage have as part of their wall a remnant of the unobliterated portion of the medullary canal or the sacrococcygeal joint, then it will be necessary to remove the coccyx in order to excise all that wall. Probably the type of closure of the wound has nothing to do with the matter of recurrence as wounds should close here as well as elsewhere if there be no pathological process at the base. The type of closure, however, does influence very decidedly the length of time for wound healing and whether or not there will result a painful scar. The double pedicle flap recommended by Lahey has proven to be most successful. Practically all the patients so closed were out of bed by the fourth day and out of the hospital in a week.

The coccyx should be removed in those patients operated on before by bloc dissection which have recurred, those in which the injection of lipiodol shows the sinus tract by X-ray to go into the sacrococcygeal joint, those in which the injection of methylene blue shows discoloration about the joint and those which show some suspicious type of tissue in the region of the sacrococcygeal joint.

CEREBELLAR ABSCESS

DR HUBLEY R. OWEN presented a boy ten years of age, who was admitted to the Hospital of the Woman's Medical College June 6, 1932, giving the history of having been hit in the head by a baseball on or about June 4, 1932. No symptoms developed until June 14, 1932, when the boy complained of headache, nausea, vomiting and restlessness at night. The provisional diagnosis was possible fractured skull with signs of compression. Both ears have discharged at intervals for the past eight years due to otitis media at the age of two years.

Physical Examination—Overdeveloped, stolid boy, not acutely ill. *Head*—Eyes, pupils equal, react to light and accommodate. Ears, left ear impacted cerumen, right ear discharging freely. No mastoid tenderness. *Chest*—Negative. *Abdomen*—Negative. *Extremities*—Babinski absent. Knee-jerks diminished. *X-ray of Skull*—No evidence of skull fracture. Rontgen evidence of convulsional atrophy. Sella is normal. *X-ray of Mastoid*—Films of the mastoid show the left mastoid to be clear, cell outlines distinct and cells pneumatic. Films of right mastoid show marked clouding of the cells and cell outlines can be faintly recognized in places but there is ap-

paiently considerable destruction of most of the cell outlines Impression, mastoiditis right side

Child complained of occasional nausea but constant headache Headache increased in the afternoon June 22, 1932, the child was quite sick, crying all day from headache Examination of eyes by Dr Mary Buchanan, ophthalmologist, showed "O2 media clear Discs well defined The vessels full and discs quite red, although not so red as the rest of the fundus No hæmorrhage or exudate as far as seen but patient is not cooperative and the details of the periphery are not obtainable through the small pupils There is nothing suggesting brain lesion or choked discs Patient follows light, movements are full, and patient seems fully conscious Cornea clear and pupils equal Respond promptly to light" Examination by Dr Winifred Stewart June 23, 1932 "All neurological signs negative Spinal puncture, pressure 22 when not crying, 40 when crying Five cubic centimetres spinal fluid removed and sent to laboratory Vomited all food" Examination June 24, 1932 by Dr George Wilson "Child is drowsy and fusses when awakened He cooperates not too well in examination No cranial nerve paralysis Pupils dilated with mydriatic Performs finger-to-nose test on left side well, on right side with moderate ataxia The tone of right upper extremity seems less than that of left Deep reflexes in upper extremities unobtainable In lowers these are present and a little subnormal Plantar stimulation on left produces flexion On right there is occasional extension of great toe which simulates a Babinski Quite often, however, when right foot is stimulated, there is extension of left big toe Position sense is normal in all four extremities, although he occasionally misalled a position on the right side He recognized objects with both hands, except that once he called a quarter, a key in right hand Pain sense is normal Abdominal reflexes could not be obtained Knee to heel normal Neck is slightly rigid Boy cries out when head is flexed Kernig sign not present Boy is obese External genitalia are small"

A tentative diagnosis of cerebellar abscess was made and the boy was operated upon June 25, 1932 under nitrous-oxide oxygen anæsthesia with ether maintenance He was operated upon by two-stage operation as suggested by Rawling First, relief of cerebellar pressure, secondly, radical mastoid Six days later, a semilunar incision was made and a flap turned forward Incision made through scalp at right inferior region just below the tentorium Skull, which was about three millimetres thick in this region, was opened with Hudson burr and enlarged by rongeur forceps Aspirating needle was inserted into right cerebellum and about 10 cubic centimetres of moderately thick greenish pus was aspirated A hæmostat was plunged into the opening, opened and withdrawn liberating considerable additional pus Abscess drained with small rubber tube Culture showed hæmolytic streptococcus The child made an uneventful recovery from this operation and June 29, 1932, mastoidectomy was performed by Dr Emily VanLoon

Necrotic bone and unhealthy granulation tissue were found in the mastoid cells but no frank pus was encountered Pressure over the antrum with curette repeatedly elicited rhythmic jerky movements of both upper and lower extremities No break in the continuity of the bone between the middle fossa and the mastoid or between the mastoid and the posterior fossa was encountered Drain was inserted into the antrum and the skin incision closed with dermal sutures

The child made an uneventful recovery from the second operation and was discharged in good condition July 25, 1932

THE PROBLEM OF RECURRENT HERNIA

The case is reported principally because of the confusing nature of the symptoms. The first impression was fracture of the skull with compression from a slow extra or subdural hæmorrhage.

DR J S RODMAN said that he had an opportunity of seeing this boy operated upon by Doctor Owen. It was remarkable that he got well so promptly and by such a comparatively simple surgical procedure. The wound was drained readily through an exposure which ordinarily would not reach a cerebellar abscess. It is difficult to prove the exact location of this abscess but the speaker wondered whether this was an extradural abscess rather than one within a lateral lobe of the cerebellum. Most of these abscesses follow middle-ear disease and a considerable number are cerebellar, but those seen by Doctor Rodman have been approachable only from the post fossa itself. He raised this question as a matter of interest, it cannot be proven and is probably only an academic point as to whether this was within the lobe of the cerebellum or not.

DOCTOR OWEN, in closing, said that the first exploration was made below the tentorium. He did not find pus in the cerebellum at the first exploratory puncture so continued the incision above into the cerebellar pontine angle but as he was unable to find pus in this location, he returned to the cerebellar region, re-explored with an aspirating needle and found the pus as noted in the case history. He was quite sure that the pus was not subdural as there was cerebellar tissue beneath the dura and pus was found rather deeply within the structure of the cerebellum.

THE PROBLEM OF RECURRENT HERNIA

DR CALVIN M SMYTH, JR, read a paper with the above title.

DR HUBLEY R OWEN said that he had had the opportunity in the past twenty-five years to operate upon a large number of hernias of almost every character. These were operated upon at the Philadelphia General, Jefferson, and the Woman's College Hospitals. Most of these operations were performed on policemen and firemen. It has been possible to conduct an accurate follow-up survey of 350 of these men upon whom he had operated for hernia.

Doctor Taylor, of Johns Hopkins, showed conclusively some years ago that unless the patients were examined by a surgeon at the follow-up clinic no accurate statistics of recurrence could be obtained. Doctor Taylor wrote a postal card to those who could not appear at the follow-up clinic. Of those patients who were re-examined by the surgeon there was a recurrence of 84 per cent whereas in those cases which reported by postal card only 34 per cent stated that they had a recurrence, which proves conclusively that the patient himself is not always cognizant of the presence of the recurrence.

In the statistics of Erdman in the service of Dr Eugene Pool the percentage of recurrence in 1,000 cases was 75 per cent. Of 665 cases of operation for oblique hernia there was 315 per cent recurrence, while of 318 for direct there was a recurrence of 1651 per cent. Erdman points out that practically 50 per cent of all recurrences were observed within six months after operation. This has been Doctor Owens' experience.

Cases for herniorrhaphy should be carefully selected and the older the patient the greater the chance of recurrence. Fifty per cent of recurrences are those who are operated upon after forty years of age. Recurrence is more apt in the obese. He attempts first to reduce by diet these obese patients. Those who are inclined to have the so-called Pool bulge are apt to have recurrence after operation.

Of course in children the operation is simple. Usually tying off the sac suffices. With oblique hernia in early adult life a Bassini operation will usually suffice but in those cases which have a large oblique hernia or a direct hernia with a poor conjoint tendon he now, after tying off the sac and transplanting the sac after the method of Barker, repairs the floor of the canal by using the transplanted sheath of the rectus muscle after the method of Halsted. He also transplants the fascia of the external oblique beneath the cord, suturing this to Poupart's ligament, not to the thin, frayed, free margin but to the shelving margin. He has seen only one case in which he regretted transplantation of the cord superficially. That case, a recent one, developed atrophy of the testicle, which had to be removed. He had for about three years performed the operation as suggested by Doctor Stettin but has discontinued this procedure.

Following operation in a child it is necessary to keep the child bedridden only for about eight to ten days, in an adult operated upon for a large oblique or a direct hernia he keeps the patient in bed for at least fifteen days and for a bilateral hernia for eighteen to twenty-one days. In the case of policemen and firemen the men are allowed to do light duty after having been discharged from the hospital for one month but are not allowed to return to active duty for a period of three months.

The frequency of recurrence above the internal ring has been mentioned. In order to minimize the danger of recurrence in this location he always places at least one suture to close snugly the internal ring above the cord.

BRIEF COMMUNICATIONS

HÆMOSTASIS DURING SPLENECTOMY

SPLENECTOMY may be a very simple operation or it may be a very difficult one. When the splenic pedicle is long and the spleen free, the operation is usually quite easy. When there is a long-standing disease of the spleen with great enlargement and adhesions accompanied by a diseased liver with its resulting pathology, serious difficulties may be offered.

In a well-developed case of Banti's disease and in other conditions, vessels of the splenic pedicle may be surprisingly large, tortuous and short, the greater curvature of the stomach, the tail of the pancreas and the splenic hilus being in close approximation. When this condition obtains, the ordinary methods of clamping and ligation or ligation by use of the ligature carrier do not work out well. The vessels are so short and so easily damaged that neither method is free from the danger of troublesome hæmorrhage, not to mention the possibilities of damage to the stomach and pancreas.

In traumatic rupture of the normal spleen, the operative procedure is usually not difficult, but rupture, traumatic or spontaneous, of a much enlarged, diseased and adherent spleen, may tax the surgeon considerably. In a case of well-advanced Banti's disease with very large tortuous vessels in the splenic pedicle and in a second case of the same disease with spontaneous rupture of a spleen weighing 1700 Gm., the writer used a method of dealing with the pedicle which seemed safe and greatly simplified the operation.

After the spleen is freed from the adhesions to its bed, is lifted and a large hot pack placed in its fossa, the pedicle is clamped with a rubber-shod intestinal clamp, far away from the spleen. If the pedicle is short, this means, in all likelihood, that the greater curvature of the stomach and part of the pancreas will be included. This gives complete control of hæmorrhage, the tail of the pancreas can be freed from the splenic hilus, if this is necessary, and the vessels in the pedicle ligated at leisure in the manner selected. There is no reason to fear damage to the stomach by the rubber-shod clamp and its application for the few minutes necessary does not damage the pancreas.

When the vasa brevia are tied individually and quite close to the greater curvature of the stomach, one feels some fear that a severe vomiting attack might push off a ligature, particularly if catgut is used. Greater security of these vessels is obtained by burying each ligated vessel with a pursestring of silk taken in the stomach border. This is a minor point in the operative technic but possibly a secondary hæmorrhage may be prevented by using it.

WALTER D. WISE, M.D.
of Baltimore, Md.

BRIEF COMMUNICATIONS

A BONE CLAMP APPARATUS FOR THE OPEN REDUCTION OF FRACTURES

THE instrument herein described was designed for the purpose of giving the operator absolute control of the mechanical forces involved in the open reduction of fractures of long bones. With the ability to manipulate the fragments at will, irrespective of contracted muscles and other resisting forces, the open reduction of fractures becomes an operation of precision which can be accomplished in a short time with a minimum of soft tissue trauma. Without perfect control over the forces interfering with reduction, the operation more often than not becomes a bungling procedure with assistants pulling and hauling on the injured limb while the operator tries to pry the fragments into place. Such inaccurate procedures are bound to be accompanied by destructive trauma to soft tissues, danger to important vessels and nerves and increased danger of infection.

The fundamental mechanical requirements for a bone-setting instrument may be summarized as follows:

First, it must be able to grasp the bone fragments so firmly that there is no danger of slipping of the instrument on the fragments during the manipulation of the fragments.

Second, it must place at the command of the operator controlled mechanical forces equal to any resistances he may encounter in the reduction.

Third, the instrument must be so designed as to provide for utmost flexibility of movements in all directions. The apparatus herein described meets all of the above requirements.

In describing this clamp to aid in the open reduction of fractures, I do not want to be understood to advocate the use of bone plates or other forms of buried foreign-body retention apparatus. I resort to open reduction only when I am unable to get satisfactory reduction by closed methods. Open reductions I practically never plate. If the fragments are difficult to hold in place, I usually rely on the simple procedure of forcing the end of one fragment into the marrow cavity of the other.

E MACD STANTON, M D
Schenectady, N Y

EXCESSIVE CALCIFICATION IN A CASE OF CHRONIC TUBERCULOSIS

THE following case of tuberculosis of the spine and lymphatic glands appears to be of interest on account of the marked and widespread calcification.

CASE I—R S, aged thirty-five years, an engineer, was admitted to the Central Middlesex County Hospital August 27, 1932, suffering from a painful swelling of the right axilla.

The patient gave a history of having suffered from enlargement of the cervical glands since 1909. In May, 1915, he sustained an injury to the spine in a motor accident, and

BONE CLAMP FOR FRACTURES

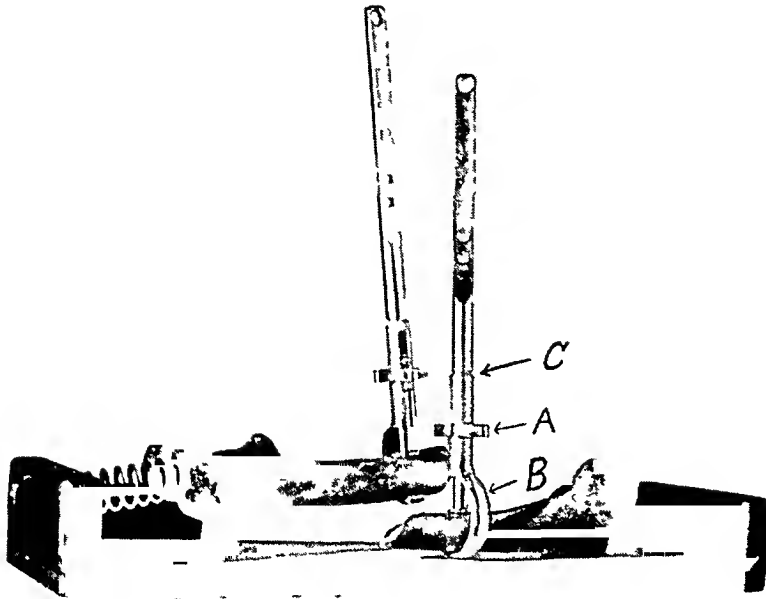


FIG 1 shows the jaws attached to the two fragments of an overriding fracture. The vise like grasp of the jaw is controlled by the winged nut (A) which forces the pin (B) against the bone. The jaw is designed to grasp bones from $\frac{5}{8}$ to $1\frac{5}{8}$ inch in diameter, a range which will include all long bones from the largest femur to a radius. The jaw handles pivot on their long axis at (C) so that no matter what the positions of the jaws may be when applied to the bones the jaw handles can be readily adjusted to fit into the controlling apparatus. The fixed portion of the jaw is so designed that it can be used as a blunt dissector and simply slid around a bone without freeing the tissues above or below the clamp.

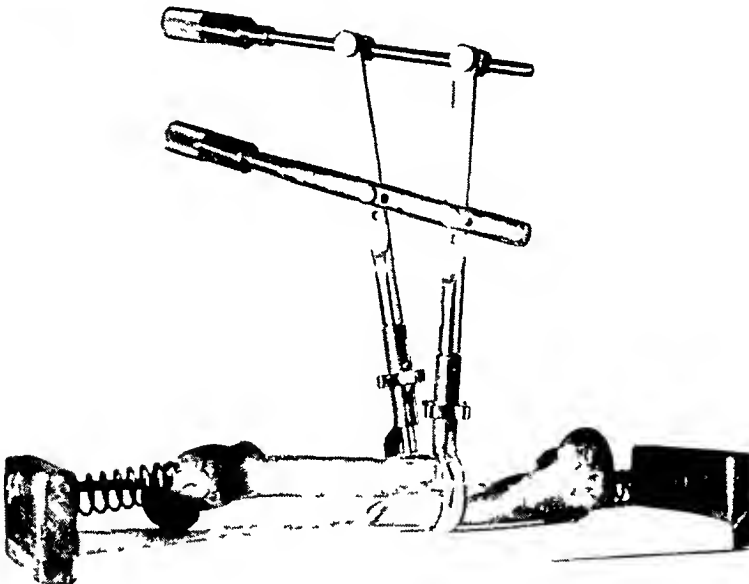


FIG 2 shows the controlling apparatus attached to the jaw handles with the bone fragments still in their original, unreduced position. When applied in the position shown in this illustration, the first part of the extension is obtained by a rotating movement of the controlling handle followed by use of the screw extension.

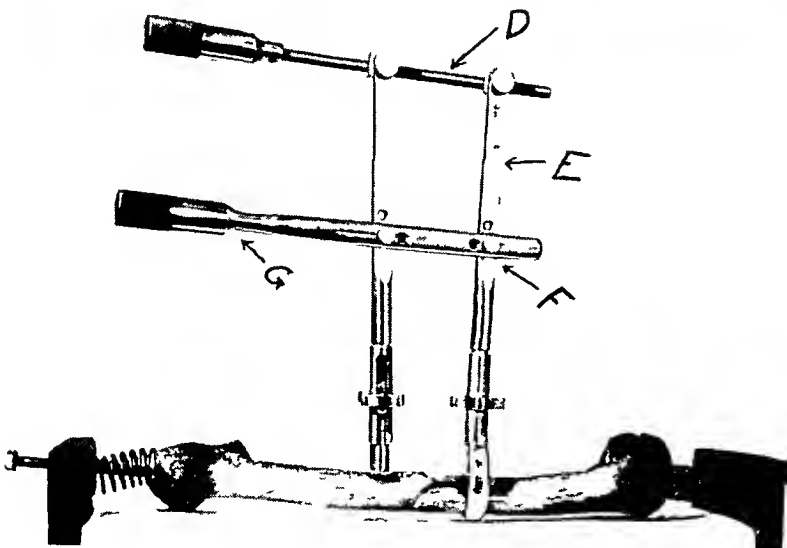


FIG 3 shows the apparatus in position with the fracture reduced. Extension is obtained by means of the right and left threaded screw (D) acting on the jaw handles (E) fulcrumed at the points (F) on the adjusting handle (G). This mechanism allows steadily applied extension which can be made as slowly and deliberately as may be necessary to allow for the gradual stretching of contracted muscles and other tissues. The operator has at his command power for producing extension far beyond any that he will actually need but the amount of extension is at all times controllable to a minute fraction of an inch.

BRIEF COMMUNICATIONS

in October of the same year developed paraplegia, which was shown by radiography to be associated with spinal caries. Postural treatment was given for three periods of six months each.

In 1918 a left psoas abscess developed, and this was soon followed by an abscess in the left lumbar region.

In 1928 the right leg became swollen, and a vein on the same side of the abdomen was noticed to be prominent, both these conditions were at first relieved by lying down.

Since the onset of the disease the patient has had thirteen operations performed at

varying intervals for abscesses developing in the neck, axillæ and groins. He had also received several courses of tuberculin treatment.

There was no family history of tuberculosis.

The general appearance of the man was good. There was a large abscess in the right axilla, beneath which firm glands could be palpated. In each axilla, on both sides of the neck, and in each groin numerous glands could be felt, many being stony hard. In the right side of the abdomen large masses—assumed to be glandular in origin—could be palpated.

Healed scars were present in both loins, in the left groin, in each axilla, and below each nipple. In the right axilla were three sinuses, each having a bluish skin margin. The spine showed a thoracolumbar kyphosis.

Extending upwards on the right side of the abdomen was a large tortuous vein which passed from the groin to the pectoral region (Fig 1). This vein filled from below upwards, and became more distended on deep expiration. There was no œdema of either leg, and no enlargement of the liver or spleen was detected.

No abnormalities were found in the heart, or in the urinary or nervous systems. Slight bronchitis was present, but the sputum contained no tubercle bacilli. The Wassermann reaction was negative in the blood, and the blood count was within



FIG 1.—Anastomotic vein coursing upwards on the right side of the abdomen.

normal limits. No tubercle bacilli were found in the feces.

Radiographical Examination—In the neck and axilla many calcified glands were clearly seen, while in the lower thoracic and lumbar spine there was evidence of old standing tuberculosis, fusion of the anterior surfaces of vertebrae could be seen as well as many areas suggesting calcification of glands or abscess walls.

This case is presented on account of several unusual features.

(1) Evidence of excessive and widespread calcification—best seen in the accompanying radiograms. There was a notable absence of glandular enlargements in the chest, in spite of marked involvement of the cervical and abdominal glands.

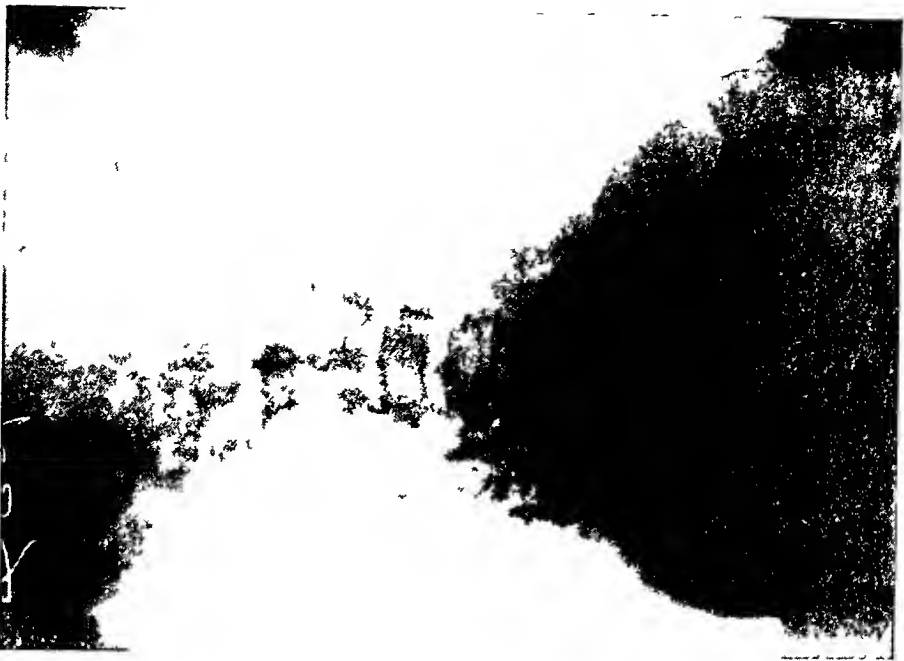


Fig. 2—Calcification of lymphatic glands on each side of neck and in the axilla



Fig. 3—Calcification of abdomino pelvic lymphatic glands and walls of abscess cavities. In the lateral view in view of new bone formation can be seen



Fig. 4—Calcification of abdomino pelvic lymphatic glands and walls of abscess cavities. In the frontal view in view of new bone formation can be seen

BRIEF COMMUNICATIONS

(2) The presence of an anastomotic vein coursing superficially upwards on the abdominal wall (Figs 2, 3 and 4) On account of the large masses felt in the right side of the abdomen, one is led to assume that this was caused by pressure on the inferior vena cava

(3) The presence of new bone formation as shown by the fusion of certain vertebræ

(4) The tuberculous infection appeared to be chiefly localized to bones and glands, with only a limited spread to adjacent structures, *e g*, skin

(5) The patient, though suffering from long-standing tuberculosis, is in good health, probably because of the limitation of the disease by calcifying processes Despite numerous abscesses and discharging sinuses at different times, no evidence of amyloid disease was elicited

N M MATHESON, F R C S (ENG)

of London, Eng

Assistant Medical Officer, Central Middlesex County Hospital

In the April issue of the ANNALS OF SURGERY attention is called to page 605 of his statement that "mupercaine should not be boiled without increasing its toxicity" The freely boiling of the mupercaine is correct

NORMAN J KILBOURNE, M D,

Los Angeles, Cal

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THE FACTORS LEADING TO DEATH IN OPERATIONS UPON THE GALL-BLADDER AND BILE-DUCTS *

BY GEORGE J HEUER, M D
OF NEW YORK, N Y

For several months past I have been assembling and studying the cases treated in the surgical wards of the new New York Hospital since its opening, September 1, 1932, and with the view of determining the results of our surgical efforts. It seems desirable that I should do this, for if I can each year learn the reasons for our successes and particularly the causes of our failures it would seem that a more orderly progress toward the solution of the many problems which still confront us might well be made. I had intended to present a summary of our total experience in the past sixteen months but I find that to do so would take me beyond the time allowed me. By accident I first began a study of our experience with the diseases of the gall-bladder and biliary ducts (exclusive of malignant disease) and in connection with it assembled the literature with particular reference to the causes of death in operations upon the gall-bladder and biliary tract. It is based upon 200 cases treated in the New York Hospital between September 1, 1932, and March 1, 1934, 800 cases which I assembled from the records of the old New York Hospital between 1922 and 1932, and 36,623 cases assembled from American and European literature, a total of 37,623 cases (Chart I). In addition to these I have studied 1,066 cases specifically of acute cholecystitis (Chart II), and 5,815 cases particularly with reference to perforation of the gall-bladder.

Since this study was prompted by the fatalities which occurred in our own experience I shall begin its presentation by stating what this experience has been. Among the 200 cases operated upon for non-malignant diseases of the gall-bladder and bile-ducts, thirty-five were cases of acute cholecystitis subjected to cholecystectomy in the acute stage, with one death (mortality 2.8 per cent), 134 were cases of subacute or chronic cholecystitis treated by cholecystectomy, with two deaths (mortality 1.4 per cent), thirty-one were cases of chronic cholecystitis and common duct obstruction treated by cholecystectomy and choledochostomy with two deaths (mortality 6.4 per cent). In the series of 200 cases comprising these three groups there were five deaths, a total mortality of 2.5 per cent.

An analysis of these five deaths, in four of which an autopsy was obtained, shows the following

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(1) A man, aged forty-one years, entered the hospital acutely ill with all the signs and symptoms of an acute cholecystitis. He was more toxic than usual and my impression was of an acute fulminating cholecystitis. He was operated upon about six hours after admission and at operation an acutely inflamed gall-bladder with one stone impacted in the cystic duct was found. A cholecystectomy was done. Following operation there was little change in his general condition, he remained seriously ill and toxic. On the third post-operative day he developed a bilateral acute parotitis, on the fifth post-operative day he showed an unquestioned bronchopneumonia, on the sixth post-operative day he developed generalized convulsions, lapsed into unconsciousness and died with symptoms of meningitis. An autopsy was not obtained.

CHART I

Gall-Bladder Operations from the Literature, Deaths and Mortality (Per Cent)

Author and Reference	Number Cases	Number Deaths	Mortality (Per Cent)
Blalock, A Bull Johns Hopkins Hospital, 35 391, 1924	735	70	9.3
Smith, M Trans Am Surg Assn, 51 287, 1933	1,053	71	6.7
Cattell, R ANNALS OF SURGERY, 89 930, 1929	890	41	4.2
Verbrycke South Med Jour, 22 452, 1929	302	21	6.9
Johnson and Pearre South Med Jour, 19 889, 1926	488	47	9.6
Cave, H ANNALS OF SURGERY, 84 371, 1926	629	35	6.8
Hitzrot, J ANNALS OF SURGERY, 84 829, 1926	482	50	10.4
Judd, Parker ANNALS OF SURGERY, 84 419, 1926	1,036	27	2.6
Bernhard Bruns Beitr Chir, 150 83, 1930	4,557	209	4.3
Hotz Arch klin Chir, 126 295, 1923	12,144	1,128	9.8
Siegmund Deutsch Z Chir, 230 359, 1924	850	46	5.4
Heuer, G West Va Med Jour, 26 1, 1930	135	11	8.1
Danzis S Clin N A, 6 1397, 1926	215	13	6.0
Davis ANNALS OF SURGERY, 87 735, 1928	160	6	3.7
Sanders ANNALS OF SURGERY, 92 375, 1930	500	20	4.0
Doran, <i>et al</i> , ANNALS OF SURGERY, 98 330, 1933	200	14	7.0
Fowler Am Jour Surg, 22 53, 1933	1,206	71	5.9
Stanton Am Jour Surg, 8 1026, 1930	10,000	500	5.0
Santee ANNALS OF SURGERY, 93 1156, 1931	333	21	6.3
Richter ANNALS OF SURGERY, 88 187, 1928	418	23	5.5
Darner Surg Gynec, and Obstet, 37 579, 1923	290	29	10.0
TOTAL	36,623	2,453	6.6

(2) A man, aged sixty years, suffering from proven generalized arteriosclerosis with hypertension and myocarditis entered the hospital with symptoms of gall-stones. A diagnosis of chronic cholecystitis and cholelithiasis was made. At operation, which was technically simple, a cholecystectomy was done and the removed gall-bladder contained seventy stones. Signs of pneumonia appeared on the second post-operative day with symptoms of myocardial failure. There was a partial suppression of kidney function manifested by a high uric nitrogen. Death occurred on the sixth post-operative day. At autopsy there was a localized biliary peritonitis, a dilatation of the right ventricle, brown pigmentation of the myocardium, generalized arteriosclerosis and hyperæmia of the lungs, liver and kidneys.

(3) A man, aged forty-four years, entered the hospital with a markedly enlarged liver and deep jaundice. The pre-operative diagnosis was difficult and he was kept under observation some time in an attempt to differentiate between stone in the common duct and malignancy in the head of the pancreas. His icteric index was 121 on admission, subsequently rose to 140, but before operation was 80. Fluids and glucose were administered and he received 10 cc of 5 per cent calcium chloride daily. After eleven

days of observation and study an exploratory laparotomy was undertaken. At operation a cholecystectomy was done and the exploration of the common duct showed multiple stones, sixteen of which were removed. The common duct was drained through the stump of the cystic duct. On the second post-operative day the patient vomited repeatedly, some of the vomitus containing blood, and had an elevated temperature, on the sixth post-operative day he vomited 10 cc or more of bright red blood following which he rapidly passed into a condition of profound shock suggesting a massive hæmorrhage into the stomach. In spite of blood transfusions he failed to rally and died. Autopsy showed one stone in the common bile-duct near the duodenal orifice, which had not been removed at operation, obstructive biliary cirrhosis of the liver, chronic obstructive interstitial pancreatitis, hæmorrhagic pancreatitis with fat necrosis, multiple erosions of the gastric and œsophageal mucosa and hæmorrhage into the stomach.

(4) A man, aged sixty-two years, was admitted deeply jaundiced with a clinical history of common-duct obstruction. He presented in addition arteriosclerotic heart disease, hypertension and a mild grade of diabetes (arteriosclerotic). At operation a cholecystectomy was done and exploration of the common duct revealed two stones which were removed. The common duct was drained through the stump of the cystic duct. His post-operative course was marked by a low-grade temperature which fluctuated daily for fifty-three days, and by a persistently increasing diabetes. He was repeatedly examined, and the possibility of a sulphuremic abscess was entertained but the diagnosis of this condition was never positively made. He died suddenly on the fifty-third post-operative day. At autopsy two very small stones were found in the common duct which had not been removed by operation, there was a chronic subphrenic abscess, a bronchopneumonia involving the right lower and left upper lobes, fibrosis of the pancreas, generalized arteriosclerosis, and cardiac enlargement.

(5) A man, aged eighty years, deeply jaundiced, was admitted with the clinical history and findings of common-duct obstruction due to stone or malignant disease. The surgical opinion, after study, favored a non-malignant obstruction. For his age the patient was considered in fair condition and was subjected to operation. At operation the gall-bladder was found to contain stones and the pancreas was enlarged and hard. A cholecystostomy was performed and twenty-five stones were removed from the gall-bladder. The common duct was examined but not opened. The gall-bladder was drained. The post-operative course was prolonged and unsatisfactory, nothing definitely was found to warrant further surgery. He died sixty-four days after operation. At autopsy there was found pneumonia (Friedlander type) with multiple pulmonary abscesses, a loculated abscess in the right pleural cavity, bronchopneumonia of the left lower lobe, pulmonary tuberculosis, and chronic pancreatitis.

In a consideration of the factors leading to death in these five cases we have to consider the operative treatment of cholecystitis in its acute stage, the consequences of operations upon the biliary tract in general, including infection of the peritoneum, hæmorrhage and shock, the post-operative pulmonary complications, and the cardiorenal complications. These and other factors concerned in the mortality following surgery upon the gall-bladder and biliary ducts I shall attempt to classify.

A summary of 36,623 cases of gall-bladder and biliary-duct disease subjected to surgery shows a general mortality of 6.6 per cent. The mortality of individual surgeons or clinics, however, shows great variations, being in the hands of some as low as 2.6 per cent, in the hands of others as high as 10.4 per cent (Chart I). A summary of 1,066 cases of acute cholecystitis subjected to surgery shows a general mortality of 8 per cent, an individual mortality varying between 4.7 per cent and 22.5 per cent (Chart II). A

CHART II

Acute Cholecystitis, Operations in the Literature with Deaths and Mortality (Per Cent)

Author and Reference	Number Cases	Number Deaths	Mortality (Per Cent)
Miller, R ANNALS OF SURGERY, 92 644, 1930	200	27	13 5
Zinninger, M ANNALS OF SURGERY, 96 406, 1931	89	7	7 6
Mentzer, S Surg, Gynec, and Obstet, 55 709, 1932	71	16	22 5
Judd and Phillips Trans Am Surg Assn, 51 292, 1933	508	24	4 7
Graham, H ANNALS OF SURGERY, 93 1152, 1931	198	12	6 0
Pratt, G Am Jour Surg, 22 46, 1933	45	10	22 2
Heuer, G West Va Med Jour, 6 1, 1930	56	3	5 0
Smith, M Trans Am Surg Assn, 51 287, 1933	107	10	9 3
TOTAL	1,274	111	8 7

summary of 502 cases of gangrene with perforation of the gall-bladder subjected to surgery shows a general mortality of 46 per cent and an individual mortality varying from 15 per cent to 65 per cent (Chart III)

CHART III

Gall-Bladder Perforations from the Literature, Deaths and Mortality (Per Cent)

Author and Reference	Number Cases	Number Deaths	Mortality (Per Cent)
Blalock A Bull Johns Hopkins Hospital, 35 391, 1924	21	?	
Smith, M Trans Am Surg Assn, 51 287, 1933	24	?	
Johnson South Med Jour, 19 889, 1926	9	9	
Judd, Parker ANNALS OF SURGERY, 81 419, 1926	2	?	
Siegmund Deutsch A f Chir, 230 359, 1924	8	5	62 5
Heuer, G West Va Med Jour, 26 1, 1930	18	?	
Danzis Surg Clin N A, 6 1397, 1926	1	1	100 0
Stanton Am Jour Surg, 8 1026, 1930	32	32	?
Santee ANNALS OF SURGERY, 93 1156, 1931	5	3	60 0
Alexander ANNALS OF SURGERY, 86 765, 1927	20	?	
Mitchell ANNALS OF SURGERY, 88 200, 1928	16	?	
McWilliams ANNALS OF SURGERY, 55 235, 1912	6	2	33 3
McWilliams ANNALS OF SURGERY, 55 235, cites	108	52	48 0
Gosset, Deplas Jour de Chir, 25 259, 1925	111	?	52 2
Darner, Cullen Surg, Gynec, and Obstet, 37 579, 1923	3	2	66 6
Zinninger ANNALS OF SURGERY, 96 406, 1931	16	?	
Miller ANNALS OF SURGERY, 92 644, 1930	8	?	
Graham ANNALS OF SURGERY, 93 1152, 1931	7	?	
Judd, Phillips Trans Am Surg Assn, 51 292, 1933	68	?	
Mentzer Surg, Gynec, and Obstet, 55 709, 1932	19	?	
TOTAL	502		

I have attempted to analyze the cause of death in this collection of cases I find that the task has been extremely difficult due to the lack of accurate information, yet it is possible to arrange the causes of death under various headings and this I shall try to do

(1) *Acute Cholecystitis, Gangrene and Perforation of the Gall-Bladder, Extracholecystic Abdominal Abscess*—In a survey of the literature it becomes apparent that the acute conditions of the gall-bladder have contributed

in no inconsiderable way to the mortality of gall-bladder and biliary-duct surgery. It is impossible from the present literature to get any accurate idea of the total number of cases of acute cholecystitis and its complications and it is impossible to estimate the total number of deaths which clearly have been due to them. It commonly has been stated by those favoring a waiting policy in acute cholecystitis that the occurrence of serious complications as gangrene, perforation and extracholecystic abscess is rare and that the mortality in gall-bladder and bile-duct surgery is conserved on the whole by waiting for the acute cholecystitis to subside. To determine the true frequency of the complications of acute cholecystitis and their dangers to the individual it is necessary to analyze, not the total cases of gall-bladder and duct disease, but solely the cases of acute cholecystitis. Unfortunately, the available information on this subject is unsatisfactory but certain figures are available.

In the New York Hospital series of 800 cases there were 106 cases which certainly were instances of acute cholecystitis and in this number are sixteen perforations and seven probable perforations of the gall-bladder, a percentage of 21. Judd and Phillips,¹ in 508 cases of acute cholecystitis, found sixty-eight with gangrene or perforation of the gall-bladder, a percentage of 13.4. Heuer,² in seventy-four cases of acute cholecystitis (Cincinnati series), found eighteen cases of gangrene, perforation or extracholecystic abscess, a percentage of 24. Zininger,³ in seventy-eight cases of acute cholecystitis, found sixteen cases of gangrene or perforation, a percentage of 20.5. Morris Smith,⁴ in 107 cases of acute cholecystitis, found twenty-four with gangrene, perforation and extracholecystic abscess, a percentage of 22.4. In the papers of seventeen authors I find the records of 502 perforations of the gall-bladder but I cannot accurately estimate the percentage this number represents of the cases of acute cholecystitis observed. It seems probable, however, that at least 20 per cent of the cases of acute cholecystitis will have the complications of gangrene, perforation and extracholecystic abscess or peritonitis if a policy of inactivity toward the disease is adopted. The mortality in operations after gangrene and perforation have taken place is high. In the New York Hospital series of sixteen perforations and seven probable perforations there were eight deaths, a mortality of 34.7 per cent. This constitutes 11 per cent of the total mortality in the series. In the experience of fourteen authors who have studied it, the mortality varies between 15 per cent and 65 per cent, with an average mortality of 46 per cent, and the mortality constitutes about 10 per cent of the total mortality in operations upon the gall-bladder and biliary ducts (Chart 2). In certain articles, as for example that of Johnson and Pearre,⁵ the mortality from perforations alone constitutes 20 per cent of the total mortality in a general series of cases. This is very largely a preventable mortality and has been due to an attitude of mind toward the treatment of acute cholecystitis on the part of the physician and surgeon. Fortunately, in my opinion, this attitude is rapidly changing. The recent publications⁶ show that an increasing number of surgeons are favoring operation in the acute stage of acute cholecystitis with which I have long been in

accord. The supposed dangers of operating in the acute stage have been over-emphasized. The removal of the acute non-gangrenous, non-perforated gall-bladder is usually not difficult and is attended by a mortality which in the hands of various surgeons has varied from 2 per cent to 6 per cent. This mortality I am sure may be lowered and by an earlier attack upon the disease. The argument that the mortality in operations for chronic cholecystitis is less than that in acute cholecystitis is still true if one eliminates the mortality from gangrene and perforation of the gall-bladder. But from my point of view this mortality is chargeable to subacute or chronic cholecystitis rather than to acute cholecystitis, for it has resulted from the attempt to convert acute cholecystitis into the chronic form of the disease.

To sum up, the experience of surgeons who have contributed to the literature on the subject indicates that the complications of acute cholecystitis, including gangrene, perforation, extracholecystic abscess and peritonitis form a factor of importance in the deaths following operation upon the gall-bladder and bile-ducts. The mortality is largely preventable and in great part can be eliminated by operation in acute cholecystitis before these complications have occurred.

(2) *Errors in Technic and Complications Traceable to the Operative Procedure*—A review of the material collected for study shows that errors in surgical technic, or if not these, then complications traceable to the operative procedure have been a factor of considerable importance in the mortality following operations upon the gall-bladder and bile-ducts. Again, it is quite impossible to state accurately how many deaths have been directly caused by these factors. In our own series of five deaths, I find that one death was due to acute bilateral parotitis and bronchopneumonia possibly the result of a cholecystectomy in acute cholecystitis. In the autopsy following a second death there was found a local biliary peritonitis, in a third a chronic subphrenic abscess and in the autopsies of two, common-duct stones had not been removed. In the last two the failure to remove all the stones from the common duct probably had nothing to do with the fatal outcome but in the first two the operative procedure contributed toward the fatalities. In the 800 cases of the New York Hospital between 1922 and 1932, peritonitis following operation and given as the major cause of death is recorded in eighteen cases, hæmorrhage in five cases and shock in four cases. These deaths form 37 per cent of the total number of deaths. Scattered mishaps, such as evisceration, failure to remove stones, *etc.*, are occasionally recorded but are rare. In the 2,392 deaths in 35,373 cases gathered from the literature I find peritonitis given as the cause of death in 450 cases, shock in 173 cases, and hæmorrhage in 141 cases. To these should be added thirty-one deaths from post-operative ileus. These factors would, if correct as given, account for 33 per cent of the deaths. But as I have stated in discussing acute cholecystitis and perforation of the gall-bladder, I have found it difficult to obtain accurate information. It is not clear, for example, in how many instances peritonitis was due to a gangrenous gall-bladder, to the spread of infection from an extracholecys-

tic abscess, to the escape of infected bile from an open duct, and so forth. Nor is it clear whether in the instances of hæmorrhage, this hæmorrhage came from the liver, from a badly ligated cystic artery or was of the nature associated with jaundice. The figures show, however, whether strictly accurate or not, that the operative procedure, and the errors in technic and judgment committed during it, are factors still of importance in the mortality following operations on the gall-bladder and bile-ducts. To eliminate them is of course our natural aim. Aside from the slow meticulous performance of the operative procedure with the least injury to organs and tissues, the careful control of hæmorrhage, the prevention of soiling of the peritoneum by adequate protection and the use of suction, I have nothing to offer in a technical way except the drainage of the common duct through the stump of the cystic duct as first described by Halsted.⁷ This in our hands has been, I feel sure, a life-saving procedure in those cases in which the common duct has been opened and merits wider adoption.

(3) *Pulmonary Complications*—Certainly to me one of the most disturbing features of surgery of the gall-bladder and bile-ducts is the high incidence of pulmonary complications. In the five deaths of our series, an extensive bronchopneumonia confirmed by physical signs and X-ray demonstration was present in the case of acute cholecystitis operated upon in the acute stage of the disease. In this case an autopsy was not obtained. In the four additional patients who died, autopsy showed pneumonia as the major cause of death in two. Of five deaths, therefore, pulmonary complications appear to have been the chief factor in causing death in three. These are the findings in the deaths but do not include the larger number of pulmonary complications from which patients have recovered but which nevertheless have been a source of great potential danger. These include seven instances of pneumonia, five of massive atelectasis, and three of pulmonary embolism and infarction. In an analysis of the deaths in the old New York Hospital cases I find pneumonia listed as the cause of death in twelve cases, and pulmonary embolism in seven cases. In four additional cases pneumonia was found at autopsy in association with a varying grade of peritonitis. In this series, therefore, 25 per cent of all deaths were due to pulmonary complications. Of the 2,392 deaths in 35,373 cases in the literature, pneumonia is given as the cause in 317, and pulmonary embolism in 137. Again, if these figures are correct, pulmonary complications have contributed 20 per cent to the total mortality in surgery of the gall-bladder and bile-ducts. It would appear, then, that post-operative pulmonary complications form one of the important factors in the mortality following surgery of the gall-bladder and bile-ducts. They form a problem which in our experience is not yet solved. The careful administration of inhalation anæsthesia, whether ether, nitrous-oxide-oxygen or ethylene followed by over-ventilation of the lungs, fails to prevent them, nor has the use of local or spinal anæsthesia in our experience aided materially in preventing them.

(4) *Cardiorenal Disturbances*—In the series of 200 cases which I have

studied arteriosclerosis of varying grade was almost a constant finding in patients over fifty years of age. Sixty-eight patients had hypertension indicated by a diastolic blood-pressure over 90, and fourteen gave a history of cardiac disease, of which ten had definite symptoms of decompensation. Of the five deaths in this series, one was due to myocardial failure with suppression of kidney function. In the 800 cases in the old New York Hospital series, 10 per cent of the deaths appear to have been caused or largely to have been caused by failure of the heart. Of the 2,392 deaths in the 35,373 cases in the literature, 285, or 12 per cent, are ascribed to cardiorenal disturbances. It would appear that not only the constitution of the individual prone to gall-stone disease but also the chronic cholecystitis itself predisposes to arteriosclerosis, hypertension and myocarditis. Early diagnosis and treatment of the affections of the gall-bladder and biliary ducts would certainly avert some of the deaths following operations for these affections. Careful study and pre-operative supervision by the surgeon of patients with arteriosclerosis, hypertension and cardiac disease may and probably do avert an occasional death after they have fallen into his hands. The problem, however, would seem to be a larger one and concerns the physician as well as the surgeon. In the 200 cases I have studied the average duration of definite symptoms of gall-stone disease was five and a half years, a period sufficiently long perhaps to provoke or to increase the changes in the vascular system so often seen in these patients.

(5) *Liver Insufficiency, Liver Death*—The train of symptoms leading to death included under the terms of liver insufficiency and "liver death" is, I presume, familiar to you. Heyd,⁹ who so far as I am aware first called attention to it as a clinical entity, describes three types. In Type I the patient with simple cholecystitis without jaundice fails to recover consciousness after cholecystectomy or lapses into a semicomatose condition and with a steadily rising temperature and pulse rate dies in a period of thirty-six hours, in Type II, the patient with obstructive jaundice seems after choledochostomy with drainage, to be progressing favorably for a few days, then presents evidence of cerebral excitation, becomes delirious, but later stuporous and then lapses into coma. Coincident with this change the escaping bile becomes less in amount and more watery in color and consistency, in Type III, less common than Types I and II, the patient with disease of the common duct and pancreas but without jaundice appears to be progressing satisfactorily for twenty-four to thirty-six hours after choledochostomy with drainage, then has a marked acceleration of the pulse, a fall in blood-pressure, a cessation of urinary secretion and exhibits cold, moist extremities. The clinical condition presented is similar to that of shock but occurs later than is usual in shock. Heyd⁹ suggests as the cause an overwhelming intoxication, probably of pancreatic origin. Transfusion and repeated infusions with ten per cent dextrose in saline may save the patient.

Since Heyd's publications on this subject quite a number of papers have appeared both in this country and abroad. Schütz, Helwig and Kuhn¹⁰

describe a series of cases which on the fifth or sixth post-operative day showed a rise in temperature and pulse rate accompanied by abdominal distention and a progressive oliguria with the appearance of albumin, casts and often red cells in the urine. The patients became delirious and then comatose, the nitrogenous elements of the blood increased and the urinary nitrogen diminished. Nausea and vomiting were often severe and bleeding from the mucous membranes frequently became a prominent feature of the clinical picture. The condition then progressed to one of uræmia with almost total anuria, the patients dying with the clinical picture of uræmia. Autopsy showed quite consistently striking degenerative changes in the liver and kidneys. The liver showed leucocytic infiltration, necrosis and interstitial hæmorrhages or marked parenchymatous and fatty changes most marked about the gall-bladder fossa. The kidneys showed parenchymatous swelling and loss of normal markings and microscopically degeneration and necrosis of the tubular epithelium. These authors conclude that damage to the liver of traumatic or infectious origin results in the formation of a selective toxin which acts directly upon the kidneys producing degenerative changes in these organs. They consider their cases analogous to Heyd's "Type I." By other authors the pancreas is thought to be seriously implicated in the condition, by still others the liver alone through absence of glycogen.

It is not within the scope of this paper to attempt a full discussion of this condition called "liver death" nor could I discuss it intelligently having seen so little of it. I have never happened to observe a death in cholecystitis without jaundice as described by Heyd under his "Type I" in which the autopsy did not reveal conditions sufficient to explain the death otherwise, but I have recently observed a death closely resembling Heyd's "Type I" in a patient upon whom I performed a splenectomy for supposed Banti's disease but which subsequently proved to be a diffuse process in spleen and liver called by one pathologist a reticulosarcoma, by another Hodgkin's disease. She died in twenty-four hours with a steadily rising temperature and pulse rate but mentally clear almost to the end, and at autopsy failed to present anything in her chest or abdomen to account for her death. The clinical picture described under Heyd's "Type II" I have long been familiar with and have chiefly been impressed with the thin, watery character of the bile. As an interne more than twenty-five years ago, I recall that W. S. Halsted, my chief, commented repeatedly upon the danger to life of the patient who at operation presented a dilated common duct containing thin, watery bile and whose bile drainage subsequently became thinner and more watery. Since that time I have at times observed this condition and it has always been associated with a very high mortality. Presumably the sudden release of back pressure upon the liver by opening and draining the common duct causes in some way the suppression of liver function and this idea has led to attempts to gradually decompress the liver by certain technics in the drainage of the common duct. With Heyd's "Type III" I have had very little personal experience but that post-operative manifestations included under Heyd's "Type III" have long

been observed but perhaps not sufficiently emphasized seems certain. Again Halsted, in 1899,¹¹ describes a case of secondary operation for common-duct obstruction which some days after operation developed a very rapid and feeble pulse, vomited persistently, the vomitus containing blood, presented cold extremities and seemed certainly beyond the hope of recovery. Rather suddenly she improved and repeated infusions of salt solution were thought to have been instrumental in her recovery.

In an analysis of the 800 cases in the new New York Hospital series the suggestion of "liver death" is noted in eleven instances. These cases presented symptoms post-operatively which resemble those described in "liver death" but are without autopsy confirmation. Of the 2,392 deaths in 35,373 cases collected from the literature, so-called "liver deaths" are recorded in ninety-five or approximately in four per cent of the deaths. At the present time the cause or causes of the condition are vague and not clearly understood, nor do we know as yet accurate tests to determine the extent of liver damage due to gall-bladder and biliary-duct disease. Graham's¹² experience with the use of iso-iodikon (dose 2.5 Gm.) would appear an encouraging step in the direction of a satisfactory test and he himself is disinclined to operate upon patients with a high dye retention. As a preventive measure the administration of dextrose pre- and post-operatively seems, in the light of our present knowledge, the most successful and the use of calcium post-operatively as suggested by Graham¹² may be of value. The occurrence of the condition is another argument for earlier treatment of the affections of the gall-bladder and biliary ducts.

(6) *Miscellaneous and Undetermined Factors*—In a study of our own series acute hæmorrhagic pancreatitis was present at autopsy in one case and in the 800 cases of the New York Hospital it was the cause of death in one case. In the literature I have assembled, pancreatitis is given as the cause of death in forty-eight cases, which represents 2 per cent of the total mortality. In reading the histories covered by our studies a great variety of miscellaneous conditions have been assigned as the cause of death but because of their infrequency are of relative unimportance as factors leading to death in operations upon the gall-bladder and biliary ducts. In about 15 per cent of all cases studied the factors leading to death could not be determined.

Summary—In a study such as this the greatest good accrues to the individual who makes it, and I apologize if I have bored you with information with which you are already familiar. Quite independently of each other I have attempted to determine the factors leading to death following operations upon the gall-bladder and biliary ducts in two groups of cases, a group of 1,000 cases assembled from the records of the New York Hospital (Chart IV) and a group of over 35,000 cases collected from American and foreign literature. Aware throughout the study that the figures I obtained for various causes of death are only approximate, yet I find on comparing these figures in the two groups of cases that they are very similar. Thus the percentage of the total mortality from the complications of acute cholecystitis as gangrene

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and perforation in the New York Hospital series is eleven per cent, in the collected cases 10 per cent, that due to the consequences of the surgical procedure as peritonitis, hæmorrhage and shock in the New York Hospital series is 37 per cent, in the collected cases 33 per cent, that due to pulmonary complications in the New York Hospital series is 25 per cent, in the collected cases 20 per cent, that due to cardiorenal complications in the New York Hospital series is 10 per cent, in the collected cases 12 per cent. These are the major factors causing death and together account for approximately 80 per cent of the deaths. Lesser causes of death are "liver deaths" (4 per cent) and deaths due to pancreatitis (2 per cent). In approximately 15 per cent of the deaths, the causes of death form a miscellaneous group of conditions or have not been determined.

CHART IV

Causes of Death—New York Hospital, 1,000 Cases, Literature, 36,623 Cases

Gangrene and Per- foration			Conse- quences of Surgical Procedure		Pulmonary Complica- tions		Cardiorenal Complica- tions		Liver Death		Pancreatitis		Miscel- laneous and Un- determined	
	NYH	LIT	NYH	LIT	NYH	LIT	NYH	LIT	NYH	LIT	NYH	LIT	NYH	LIT
	11%	10%	37%	33%	25%	20%	10%	12%	7%	4%	7%	2%	17%	19%

These figures, inaccurate though they may be, so closely correspond in two groups of cases studied independently that I think they are of significance and suggest the direction our efforts should take in attempting to reduce the mortality following operations upon the gall-bladder and biliary ducts. An intelligent selection of cases for early operation in the acute stage of acute cholecystitis will, I am sure, largely eliminate the 10 per cent mortality now occurring in the general run of patients with gall-bladder disease and the higher mortality in acute cholecystitis. So, too, more meticulous surgery combined with earlier diagnosis and treatment will reduce and, I think, greatly, the combined mortality from the consequences of the operation, including peritonitis, hæmorrhage and shock, from cardiorenal complications and from liver insufficiency, which in its totality accounts for approximately 50 per cent of the deaths, and may reduce, chiefly by operating from one-half to one or more decades earlier in life the mortality from pulmonary complications. A consideration of the causes of death and their elimination cannot fail to make evident the importance of early treatment in diseases of the gall-bladder and biliary ducts. The difficulties which beset the surgeon during the operation and after largely are the results of deviations from the normal, the result of prolonged disease, the cardiorenal complications largely are the result of prolonged disease as is damage to the liver resulting in the so-called liver deaths. The deeply jaundiced patient with common-duct obstruction with his low vitality, his non-resistance to infection, his liver damage, and his tendency to hæmorrhage is the result of prolonged disease, and he will

die all too frequently notwithstanding the best surgery Our efforts toward lowering the mortality in gall-bladder and biliary-duct disease should be in two directions, to persuade the physician and patient that safety lies in early surgical treatment and to perfect our own judgment and technic in the performance of this surgical treatment

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IMPORTANT FACTORS IN THE SURGICAL TREATMENT OF CHOLECYSTITIS

BY HENRY F GRAHAM, M D , AND HENRY S WATERS, M D
OF BROOKLYN, N Y

THERE has been no improvement in the mortality from gall-stone disease during the past decade, as shown by the data of the Metropolitan Life Insurance Company, which correspond closely with the general results published for the United States registration area. During this period, there have been marked advances made in our knowledge and methods of treatment of these cases. Amazing mortality results have been obtained in some of our large centres. Henry Cave¹ reported, eight years ago, the splendid mortality of 6.8 per cent in 515 cases of biliary disease at the Roosevelt Hospital. Since that time, The Mayo Clinic has reported a 3 per cent mortality in 703 operations for benign lesions of the gall-bladder and bile passages and 2 per cent mortality for cholecystostomy and cholecystectomy in 656 cases (1932 report). Evans Graham, after carefully eliminating the bad risks by his liver-function dye test (phenol-tetra-iodo-phthalein), showed a mortality of 4 per cent in 224 cases operated upon in 1929-30-31. Yet one of our large and good metropolitan hospitals in its published surgical reports for 1928-1932, inclusive, shows 460 operations with fifty-two deaths, or 11.3 per cent mortality. Another in the 1932 report shows over 13 per cent mortality in fifty-two cases. This is much too high.

We have prepared this paper in the hope that it may stimulate further analyses of gall-bladder mortality in our hospitals and prove a useful summary of our present knowledge of the care of these cases. Pulmonary and cardiac complications are the ones most to be feared.

Overholt² has demonstrated the following facts:

- (1) Chest expansion is diminished 75 per cent after operations in the upper abdomen.
 - (2) The excursion of the diaphragm is diminished 50 per cent after abdominal operations.
 - (3) Vital capacity is diminished 64 per cent after operations in the upper abdomen and 15 per cent by a tight binder.
 - (4) Morphine, by its relief of pain, increases vital capacity.
- The value of carbon dioxide in compelling deep breathing is generally accepted.

Hugh Cabot³ says: "My own experience in the past year seems to indicate that the routine administration of carbon dioxide has very importantly diminished the number of post-operative lung complications. I incline to the view that the post-operative use of carbon dioxide is the most important single contribution to the ultimate safety of anæsthesia which has been made in many years."

¹ Read before the New York Surgical Society, January 24, 1934.

Eliason⁴ points out the danger of undressing patients, particularly men who have been used to heavy clothing, and putting them in bed in a thin cotton nightgown

Gordon Heyd⁵ has made a valuable contribution by emphasizing that glucose is good for both acidosis and alkalosis and the prevention of sudden death following operations upon the gall-bladder and ducts

Experimentally, normal function of the liver seems to occur with only 15 per cent of normal hepatic tissue if the animal is kept on a diet high in carbohydrates—mostly milk and syrup—but, if meat is given, cirrhosis with ascites will develop and the animal will die. This is a striking indication for pre-operative and post-operative treatment, when one considers that almost every case of cholecystitis shows evidence of an accompanying hepatitis

When first seen, these patients with cholecystitis are immediately classified as acute or chronic. We believe that the acute cases should be operated upon as promptly as is consistent with safety. This usually means within a few hours. Walton⁶ says: "Since it is impossible to determine whether the inflammatory changes will progress or resolve, an operation should always be advocated in the early stages. If carried out within the first twenty-four hours, it will be as free from danger as the corresponding one performed for acute appendicitis."

Three years ago, one of us (H. F. G.), analyzed 198 consecutive operations for cholecystitis. Twenty patients were operated upon within forty-eight hours of the onset of acute symptoms. There were no deaths from early operation when acute cholecystitis was the only disease present at the time of operation. The one patient who died had an acute pancreatitis already present before operation.

These early operations were usually simple ones. The post-operative complications were few. The days in the hospital and the dressings were few. There were no ruptured wounds and the cost to the patient was low.

"Watchful waiting" was formerly considered the proper policy in acute cholecystitis, but a survey of the recent literature shows a steadily increasing tendency among our best surgeons to operate early. Pratt⁷, reporting the cases of acute suppurative and gangrenous cholecystitis from Wayne Babcock's service for a period of thirteen months, mentions twenty-three cholecystectomies performed within twenty-four hours after admission to the surgical service. All recovered. About 25 per cent were approximately sixty years of age. In the entire series of forty-five cases, there were no deaths when the operation was performed within forty-eight hours after the onset of the colic. Stone and Owings⁸ have practiced cholecystectomy on all forms of acute gall-bladder disease over a period of years, without the loss of any of them. Judd and Phillips, Lund, Miller, Homans, Royster and Finney at the last meeting of the American Surgical Association all expressed themselves definitely in favor of early operation. We think that the time has now arrived when one must justify delay in removing an acutely inflamed gall-bladder.

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The cases of chronic cholecystitis require more study. In many of them, a more or less extensive rehabilitation must be attempted. We will assume that a correct diagnosis has been made.

Allen Whipple¹⁰ has called attention to the greatly increased post-operative morbidity when upper respiratory infections were present before operation. One such patient in our series was sent home for two weeks to return later for a successful cholecystectomy. One patient had twenty-one teeth removed and another eight teeth removed before operation.

A woman, aged fifty-seven, five feet five inches tall, weighing 177 pounds, short of breath and with a systolic murmur over the cardiac area, was referred back to her family physician for cardiac treatment and reduction in weight. Five weeks later, after a loss of seven pounds in weight, an acute attack rendered operation imperative. A successful cholecystectomy was done for acute suppurative cholecystitis with stones.

A man, aged sixty-eight, was seen at his home in consultation, suffering from acute cholecystitis. His pulse was almost imperceptible and his heart sounds were poor. Non-operative treatment was advised. After three days, he entered the hospital with a palpable mass in the gall-bladder region, but we delayed another four days, because of his alarming cardiac condition. Digitalis by mouth and glucose solution intravenously were followed by progressive improvement in his general condition, so that he finally had a cholecystectomy, without post-operative complication.

Transfusions may be necessary for anæmia and chronic jaundice.

Calcium chloride or lactate and glucose solutions are indicated when post-operative hæmorrhage is feared.

Every jaundiced patient should have an estimation of the coagulation and bleeding time.

We have had no personal experience with Evarts Graham's functional liver test, but in his hands, it seems to have been 100 per cent perfect, for he went one entire year without an operative gall-bladder death. Our only question is whether this test is too perfect and denies operation to some who ought to have it.

All patients who are to have a gall-bladder operation should have a high carbohydrate diet, without meat, immediately preceding the operation, unless vomiting or diabetes prevents. This means cereal, fruit juices, hard candy, tea with sugar, oatmeal gruel with sugar, crackers, toast, baked potato, etc.

Every case should receive at least one infusion of 500 cubic centimetres of 10 per cent glucose solution intravenously before operation. It is usually given immediately preceding the operation. Patients suffering with acute cholecystitis who are good operative risks may need no further preparation than the glucose intravenously and cleansing of the skin area.

Operative technic seems to be well standardized. We wish merely to emphasize the advantages of cholecystectomy without drainage whenever possible. One anatomical variation is important to bear in mind. An accessory right hepatic duct is sometimes found emerging from the liver in the fossa of the gall-bladder and running a variable course to enter the common

bile-duct If unrecognized and not ligated, it is a source of great danger, as death from biliary leakage may ensue

I quote from E. Stair Judd¹¹ "Closure of the wound without drainage is a perfectly safe procedure if the surgeon is certain that the cystic duct and artery have been securely tied, if the fossa of the gall-bladder has been carefully sutured, and if the operative field is dry" "Closure without drainage favors healing and lessens the incidence of postoperative hernia" De Courcy¹² shows a mortality of 27 per cent in a series of 36 cholecystectomies without drainage Goldish and Gillespie¹³ have shown that undrained cases average 3.6 days shorter time in the hospital than the drained ones

We have analyzed a series of 155 consecutive cholecystectomies, without drainage, that have been done by a few of us who have been associated in this work for some years There have been nine deaths, giving a mortality of 5.8 per cent We believe that freedom from the pain caused by a drain is an important factor in permitting deep breathing, following an operation

It is obvious that gall-bladder operations tend to diminish the depth of inspiration, with a resultant tendency to pulmonary congestion, atelectasis and interference with the circulation, especially of the right heart, due to diminished negative pressure on the great veins of the thorax Large doses of the barbiturates for hypnosis during the post-operative period will also cause shallow breathing

To prevent these ill effects, the following are important (1) Eliminate the binder entirely (2) Avoid large doses of the barbiturates (3) Use morphine in moderate doses for relief of pain (4) Use the sitting position to aid the accessory muscles of respiration and take the weight of a heavy, fat abdomen off the diaphragm during inspiration (5) Use inhalations of carbogen (10 per cent or 15 per cent) for five minutes every two hours for at least twenty-four hours, even if it hurts (6) Teach each patient to breathe deeply every fifteen or twenty minutes "To avoid pneumonia" and nearly every one will do it voluntarily (7) Use a shoulder cape or blanket to prevent chilling, especially at the zero hour when the steam is off If you will investigate, you will find that this is not an infrequent occurrence In summer, excessive perspiration, open windows and drafts increase the danger of surface chilling

The glucose solutions should be continued intravenously and subcutaneously after operation until fluids are taken freely by mouth In patients, who had not previously responded well to glucose alone, some remarkably good recoveries have been obtained at The Mayo Clinic, by adding ten to twenty Gm of sodium lactate to the glucose solution administered intravenously If a cough with thick, tenacious sputum develops after operation and bronchial occlusion with atelectasis is feared, steam inhalations and liquefying expectorants should immediately be used

Our attention and interest were first centred upon this problem in September, 1932 In the sixteen months since that time, we have done sixty gall-bladder operations on the First Surgical Service at the Methodist Hospital with four deaths, a mortality of 6 $\frac{2}{3}$ per cent In our first forty-

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eight operations, we had two deaths, a mortality of about 4 per cent, while there have been two additional deaths in our last twelve cases

These results may not be striking, but we are convinced that a definite, well-planned routine is essential for the successful operative treatment of patients suffering from cholecystitis

A detailed account of the deaths is added to invite criticism

CASE I—September 20, 1933, L. A., a woman, aged sixty-seven, was sent in to the Medical Service at the Methodist Hospital by the surgeon who later operated upon her. Seven years before, she had suffered from an apoplectic stroke and dizziness had persisted since that time. For three weeks she had been ill with nausea, vomiting and dizziness. Her blood-pressure was 230/130 on admission.

She remained on the medical service nine days, during which time she was nauseated and vomited daily. Her blood chemistry was normal. No relief was obtained from medical treatment, so a cholecystectomy was requested and performed.

An adherent gall-bladder, containing a stone near the cystic duct, was removed. On the following day, the patient seemed stronger and on the second day after operation the pulse was regular and slow, the color was good and the abdomen was soft. As evening approached, however, the pulse became very irregular, there was a general convulsion and the patient suddenly expired (October 1, 1933).

Known to be a desperate risk, the question here was one of mortality statistics versus an effort to relieve an otherwise incurable case.

CASE II—January 9, 1933, a woman, aged fifty-eight, was admitted to the Methodist Hospital. She had been ill for twenty-four hours with severe epigastric pain. On admission, there was a distended abdomen, blue lips, distant heart sounds and an almost imperceptible pulse. The diagnosis was acute cholecystitis or pancreatitis. She was considered an impossible operative risk. Eleven days later, operation revealed a perforated gall-bladder full of stones, with an abscess outside and a swollen pancreas.

The abscess was packed with iodoform gauze and a tube inserted.

The post-operative course was quiet for about three weeks, except that great weakness and listlessness were noted. The patient seemed tired all the time. Then a low-grade, irregular temperature appeared, and a secondary drainage operation was performed, re-opening the old wound, which looked unhealthy. Later vomiting commenced and gradual failure. Death ensued on February 25, 1933—thirty-six days after operation. An autopsy showed a general peritonitis with pus in the pelvis and flanks. The pylorus was adherent to the liver and the lesser peritoneal sac was filled with 50 cubic centimetres of yellow pus. Several small abscesses were present in the fat behind the pancreas and right kidney.

CASE III—February 23, 1933, M. R., a woman, aged thirty-five, was admitted to the Methodist Hospital. For five weeks she had suffered from repeated attacks of pain in the right upper quadrant, jaundice, chills and light colored stools. Operation was performed six days later. A thick-walled, white gall-bladder containing one stone was removed and the common duct, which was dilated, was drained by a T-tube.

There was a considerable quantity of sanguinopurulent discharge from the wound. On the eleventh day, after operation, there was a profuse hæmorrhage from the wound. Transfusions were given as follows: 1,000 cubic centimetres on the eleventh day, 900 cubic centimetres on the sixteenth day, and 900 cubic centimetres on the nineteenth day. On the twenty-eighth day, operation revealed a pelvic abscess and intestinal obstruction. A colostomy was done. Cultures from the wound showed *B. coli*, non-hæmolytic streptococci, Gram-negative extracellular diplococci. There was gradual failure and death April 22, 1933—fifty-three days after operation.

Autopsy showed a subacute general peritonitis and pelvic and mesenteric abscesses.

This patient, unlike the previous one, was not lethargic but was a high-strung, excitable Spaniard

CASE IV—This is the only "doubtful" case from the standpoint of lack of drainage November 27, 1933, A. E. B., a female, aged sixty-one years, entered the Methodist Hospital. She had been ill for nearly a month with recurring epigastric pain and vomiting. For forty-eight hours before admission, the pain and vomiting had been more severe. On admission, her temperature was 101.8°, pulse 96 and respirations 24. The leucocytes were 14,750 and the polymorphonuclears were 82 per cent.

Five hundred cubic centimetres of a 10 per cent solution of glucose were given intravenously and three hours later a forty-five-minute cholecystectomy without drainage was performed. A large, thick-walled gall-bladder was removed intact. When opened, after the operation, it was found to contain mucus-pus. The area surrounding the gall-bladder showed no evidence of infection, but the liver showed marked hepatitis. Her temperature became normal on the fifth day after operation and remained so until the fourteenth day. Convalescence was smooth, but the patient seemed despondent and listless. Primary union occurred in the wound, but the tissues seemed "flabby." She was out of bed and sitting in a chair on the twelfth day. Later she began to vomit, developed a tender mass below the liver and a high temperature with chills.

A second operation revealed a few drops of pus beneath the liver and many adhesions of the liver to the pylorus, duodenum and colon. There was no definite collection of pus or bile. Death ensued twenty-four hours later (December 15, 1933), on the seventeenth day after operation.

An autopsy showed an area of necrosis above the gall-bladder fossa buried in the liver substance. There was also a peritonitis in the pelvis with thick patches of grayish fibrin evidently of some days' duration. There was no evidence of any biliary leakage.

Drainage might (?) have saved this patient, but the two other deaths chronicled above, with similar findings at autopsy, were both "drained" cases.

All three patients had been ill a long time before operation, and were suffering from poor nutrition.

Note the ages of three of the four patients who died—fifty-eight, sixty-one and sixty-seven years. Goldish and Gillespie have shown that the average age of the patients who died after operation was 10.3 years greater than that of those who lived.

There was one impressive fact about Cases II, III and IV. Each of them seemed, in an indefinable way, to lack the power of resisting infection.

Two were drained and one was not drained at the time of operation, yet the autopsy findings were almost identical in all three—pelvic abscess.

Severe liver damage was present in all. The question arises, "Does the liver help to prevent infection aside from its digestive and nutritional functions?"

In this series of fifty-five cases, there were no deaths from pulmonary complications, nor were there any "liver deaths," with high temperature, following operation.

The fallacy of statistics in a small series such as this is well shown by the fact that we had only two deaths in our first forty-eight cases—about 4 per cent—while there were two additional deaths in our next seven cases, making a total of four deaths in fifty-five cases, or about 7.3 per cent mortality in all.

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ACUTE CHOLECYSTITIS*

A STUDY OF 75 PROVEN CASES WITH SUBSIDING OR SUBSIDED CLINICAL MANIFESTATIONS AT THE TIME OF OPERATION

By ARTHUR S. W. TOUROI, M.D.

OF NEW YORK, N. Y.

FROM THE SURGICAL SERVICE OF DR. HAROLD STUCH, MT. SINAI HOSPITAL, N. Y. C.

THE typical syndrome of acute cholecystitis consisting of abdominal pain, tenderness, muscular rigidity, nausea and vomiting, a palpable mass in the upper abdomen, fever, a rapid pulse rate and leucocytosis, is so well known as hardly to require repetition. In a given case, after a varying period of time, these clinical manifestations undergo alteration, and become either more marked or else commence to subside. If the former occurs, the assumption is that the inflammatory process is progressing. After a period of observation, the length of which depends on the severity of the manifestations and the judgment of the surgeon, if the course is one of progression the patient is usually operated upon. The pathological lesion in the gall-bladder at operation, under such circumstances, is found as a rule to be a severe one. Conversely, if the clinical course is one of improvement, the assumption is that the process is subsiding, and when clinical manifestations become absent, it is assumed that the acute inflammatory reaction has subsided completely.

In our experience these interpretations, although admittedly correct in the majority of instances, are not infrequently erroneous. After having personally encountered several cases of acute cholecystitis of severe grade in the presence of subsiding and subsided clinical manifestations at the time of operation, the author became interested in the subject. As a result, an investigation of the general surgical files of the Mt. Sinai Hospital was made, with the view of determining the nature and frequency of acute inflammatory changes that had persisted in the gall-bladder.

(1) After clinical manifestations of an acute attack had become minimal

(2) After clinical manifestations of an acute attack had disappeared

During the period from 1929 to 1931 inclusive, 429 operations for gall-bladder disease were performed in the surgical ward services. The clinical diagnoses at the time of admission (*i.e.* acute, subacute, or chronic cholecystitis) were disregarded and all cases which, on pathological examination, had shown acute inflammatory changes in the gall-bladder, were reviewed. Of these, any case that had had acute or well-marked clinical manifestations at the time of operation was eliminated from further consideration. Seventy-five cases with acute cholecystitis proven by microscopical examination thus remained, of which twenty-three had had only minimal clinical manifestations at the time of operation, while fifty-two had been entirely free of clinical manifestations at a corresponding time.

* Presented before the Surgical Section of the New York Academy of Medicine, February 2, 1934.

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A discussion of these cases constitutes the basis of our communication. The reader is reminded that our basis for selection of material for study was a proven diagnosis of acute cholecystitis in each instance. Our presentation is concerned, therefore, with cases in which unusual clinical findings (*i e*, mild or absent manifestations) exist in the presence of *proven* acute cholecystitis. It does not deal with the subject of the general pathological findings in *clinical cases* of acute cholecystitis that have subsiding or subsided manifestations. This differentiation, as will be seen later, is of importance.

Each of the diagnoses to be enumerated had been made on microscopical examination, and not on gross inspection at the time of operation. In addition, a gross diagnosis at the time of operation had been made, in the event of such complications as a perforation, fistula between the gall-bladder and a neighboring viscus, pericholecystitic abscess, *etc*, the presence of which could not have been readily determined in the laboratory after the specimen had been removed from the abdomen. In studying the cases, it was found that gross interpretation of the pathological process in the gall-bladder at the time of operation often had been incorrect, when compared with the later microscopical diagnosis, especially in the advanced cases. For example, in several instances a gross interpretation of gangrenous inflammation proved on microscopical examination to have been merely phlegmonous or hæmorrhagic inflammation with destruction of the mucosa. It was because of such errors that we adopted the criterion of microscopical diagnosis in selecting our cases.

GROUP I—*Cases of proven acute cholecystitis in the presence of clinical manifestations which have become minimal*

The following case, although unusual, strikingly illustrates the above syndrome.

A male of fifty-six was admitted to the medical service of the Mt Sinai Hospital with the following history. Four years previously he had had a one-week episode of attacks of right upper quadrant pain which occurred ten to fifteen minutes after meals. Pain was aggravated by the ingestion of fats or meat. No associated symptoms were present except belching after meals. His physician diagnosed the ailment as due to a gastric ulcer, and prescribed a meat-free and fat-free diet which afforded considerable relief of pain. Belching was relieved by the ingestion of bicarbonate of soda. He felt comparatively well on this regime for four years.

Three weeks before admission, he was seized with sudden, severe pain in the right subcostal region. Pain radiated to the suprapubic region and was accompanied by much pyrosis and belching. Induced vomiting caused some relief of pain, but complete relief was afforded only by morphine. There was no known fever or other associated symptoms. During the three weeks prior to admission he complained only of slight epigastric pain.

On admission, temperature was 100°, pulse 80 and respirations 20. The patient did not appear acutely ill. The only positive abdominal findings were a palpable liver and spleen. There was no rigidity, tenderness or palpable mass present. Blood count: white blood-cells, 12,000, polymorphonuclears 81 per cent. The admission diagnosis was "penetrating gastric ulcer or carcinoma." He was observed for several days, during which time he complained only of slight epigastric pain. Temperature varied between 100° and 100.6°. Pulse rate, 78 to 92. On the fifth day a barium meal was given and X-ray films taken. On the next day, without warning he was seized with violent pain in the right upper quadrant. Shortly thereafter continuous vomiting began. He

rapidly went into a state of collapse, the abdomen became tender, and board-like rigidity set in. The temperature rose to 104° and the pulse to 116.

At operation, a large amount of blood and pus was noted in the peritoneal cavity, especially along the right side. A large perforated, necrotic gall-bladder filled with stones was found. Cholecystostomy, with drainage of Morrison's pouch, was rapidly performed. The patient did well for two and a half weeks and then developed chills and septic temperature. He died on the twentieth post-operative day. Pus from the gall-bladder was reported to contain *B. coli* and *Streptococcus anihemolyticus*.

At post-mortem examination the essential cause of death was found to be fibrino-purulent pelvic peritonitis.

In the above case, although the clinical manifestations were minimal after the subsidence of an acute episode, an inflammatory lesion of the gall-bladder not only was present but apparently slowly progressed over a period of weeks, until the viscus became almost totally necrotic and ruptured into the free peritoneal cavity. It was not until sudden and extensive peritoneal invasion had occurred that the patient developed alarming manifestations.

The existence of acute inflammatory changes in the gall-bladder associated with clinical manifestations which have subsided to such a degree that they are slight or minimal at the time of operation, has been reported by several authors, including Mentzer,¹ Ziminger,² and H. F. Graham.³ In our series there were twenty-three such cases (Table I). They may be divided into two sub-groups, as follows:

(A) Those showing "acute cholecystitis" (unqualified), four cases, or 17.4 per cent.

(B) Those showing more severe acute lesions ranging from acute diffuse inflammation to empyema, gangrene, and perforation, nineteen cases, or 82.6 per cent.

TABLE I

Pathological Diagnoses in 23 Cases of Proven Acute Cholecystitis in the Presence of Minimal Clinical Manifestations at the Time of Operation (Group I)

Pathological Diagnosis	Number of Cases
<i>Sub-group A</i>	
Acute inflammation	4 cases, 17.4%
<i>Sub-group B</i>	
Acute inflammation with empyema	2 cases
Acute inflammation with perforation	1 case
Acute inflammation with pericholecystitic abscess	1 case
Acute inflammation with perforation and pericholecystitic abscess	1 case
Hæmorrhagic inflammation with empyema and pericholecystitic abscess	1 case
Phlegmonous inflammation	1 case
Phlegmonous inflammation with empyema	1 case
Suppurative inflammation with empyema	1 case
Gangrenous inflammation	4 cases
Gangrenous inflammation with empyema	3 cases
Gangrenous inflammation with empyema and pericholecystitic abscess	1 case
Gangrenous inflammation with empyema and perforation	1 case
Gangrenous inflammation with perforation, pericholecystitic abscess and cholecysto-gastric fistula	1 case
	19 cases, 82.6%
Total number of cases—23	

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Examination of Table II reveals the fact that in all of the cases of Group I at the time of operation the temperature was low, ranging from 98.6° to 100°, except in one instance, in which it was 100.4°. The pulse rates varied from 72 to 88 in all but five cases. In these five cases, one was 92, one was 96 and three were 100.

TABLE II

Temperature, pulse rate and residual manifestations in 23 cases of proven acute cholecystitis in the presence of minimal clinical manifestations at the time of operation (Group I)

<u>Pathological Diagnosis</u>		<u>Temp.</u>	<u>Pulse</u>	<u>Residual Manifestations</u>
<u>Sub-Group A</u>				
1.	Acute inflammation	100	88	Some rigidity and tenderness in R.U.Q.
2.	" "	98.6	78	Slight R.U.Q. tenderness.
3.	" "	98.6	80	Slight R.U.Q. pain; Slight icterus.
4.	" "	98.6	84	Slight R.U.Q. tenderness, small non-tender mass.
<u>Sub-Group B</u>				
5.	Acute " with empyema	99.2	64	Slight R.U.Q. pain.
6.	" " " "	99.0	80	Slight R.U.Q. tenderness.
7.	" " " perforation	99	88	Slight rigidity and tenderness in R.U.Q.
8.	" " " pericholecystitic abscess	98.6	76	Slight pain and R.U.Q. tenderness.
9.	" " " perforation and pericholecystitic abscess	98.6	88	Slight R.U.Q. rigidity; Slight icterus.
10.	Hemorrhagic " " empyema and pericholecystitic abscess	99.8	84	Moderate abdominal tenderness. Palpable mass.
11.	Phlegmonous inflammation	99.	72	Pain and tenderness in R.U.Q.
12.	" " " with empyema	98.6	80	Slight R.U.Q. tenderness.
13.	Suppurative " " "	99	66	Non-tender mass deep in R.U.Q.
14.	Gangrenous " "	99.4	76	Tenderness in R.U.Q. Slight icterus.
15.	" " "	100	86	None
16.	" " "	99.8	84	Small non-tender R.U.Q. mass. Slight icterus.
17.	" " "	100	100	None
18.	" " " with empyema	99	86	Slight icterus. Tenderness in R.U.Q.
19.	" " " " "	100.4	100	Moderate R.U.Q. pain.
20.	" " " " "	100	100	Pain and tenderness in R.U.Q.
21.	" " " " and pericholecystitic abscess	99.8	96	Non-tender mass in R.U.Q.
22.	" " " with empyema and perforation	100	84	Slight epigastric pain. Rupture into free peritoneal cavity. Then collapse. Pain, tenderness, rigidity in R.U.Q. Vomiting and fever.
23.	" " " with perforation, pericholecystitic abscess, and cholecysto-gastric fistula	100	92	Mild R.U.Q. pain, Small hard, irregular, tender mass.

In none of the cases were the manifestations of acute cholecystitis marked at the time of operation. Slight tenderness and rigidity in the right upper quadrant, slight pain, slight icterus and an occasional non-tender or slightly tender mass of variable size, were the usual signs and symptoms present, and it is to be noted that not more than any two of these existed simultaneously in the same patient. Acute clinical manifestations had been replaced by those of minimal severity for from one to twenty-five days prior to the time of

operation The pre-operative diagnoses included such terms as chronic, subsiding acute, subsided acute and subacute cholecystitis, thus demonstrating the clinical impressions made on the various observers at the time of operation

Table III lists the number of days that the minimal clinical manifestations had existed prior to the time of operation and the pathological findings in each case

TABLE III

Number of Days of Minimal Clinical Manifestations Between Subsidence of Acute Attack and Time of Operation (Group I) Pathological Findings in 23 Cases

1 day		2-4 days		5-7 days		8-21 days		21-25 days	
<i>Sub-group A</i>									
Acute	1	Acute	1	Acute	1	0		Acute	1
<i>Sub-group B</i>									
Gangrenous with empyema	3	Acute with perforation	1	Acute with perforation and pericholecystitic abscess	1	0		Acute with pericholecystitic abscess	1
Phlegmonous	1	Gangrenous	2	Gangrenous	1			Gangrenous with empyema and perforation	1
		Acute with empyema	2	Phlegmonous with empyema	1				
		Gangrenous with empyema and pericholecystitic abscess	1	Gangrenous with empyema	1				
		Hæmorrhagic with empyema and pericholecystitic abscess	1	Gangrenous with perforation, pericholecystitic abscess, and cholecysto-gastric fistula	1				
		Suppurative with empyema	1						
<hr/> 5		<hr/> 9		<hr/> 6		<hr/> 0		<hr/> 3	
Total number of cases—23									

GROUP II—*In addition to the group of cases described above, there is an equally important and perhaps even less recognized group in which acute inflammatory lesions of the gall-bladder exist even after the clinical manifestations have subsided completely*

As an example, the following illustrative case is briefly presented

A female of fifty-seven with a history of having had a single attack of acute cholecystitis ten years previously was admitted to the Mt Sinai Hospital because of cramp-like pain in the right upper quadrant, which radiated to the left shoulder, of forty-eight

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hours duration For forty-eight hours the bowels had not moved During the first thirty-six hours there had been repeated vomiting

On admission, temperature was 101.4°, pulse rate 104 and respirations 22 The positive abdominal findings were a palpable liver and a tender, rounded right upper quadrant mass about three inches in diameter The overlying abdominal wall was rigid, and the abdomen slightly distended Blood count white blood-cells, 12,000, polymorphonuclears, 75 per cent A diagnosis of acute cholecystitis was made Under conservative treatment all manifestations gradually subsided, and finally disappeared at the end of seven days

The patient was then kept under observation for an additional period of nine days in order to insure complete subsidence of the inflammatory process before operation During these nine days she was up and about, had normal temperature and was entirely free of symptoms

At operation, a tense, acutely inflamed gall-bladder measuring 5 inches by 3 inches was found covered with inflamed adherent omentum The lumen contained purulent bile and two large stones Several small abscesses were seen in the wall of the viscus Cholecystectomy with drainage was performed Convalescence was uneventful

Pathological Report—Chronic and acute suppurative cholecystitis

In the above case the patient was entirely symptom-free for a period of nine days before operation, and pulse and temperature were normal Nevertheless, at operation, acute suppurative cholecystitis was found

In our series, there were fifty-two cases of proven acute cholecystitis in which complete subsidence of clinical manifestations had occurred prior to the time of operation (Table IV) The larger number of cases in the group with absent clinical manifestations as compared with the group with minimal manifestations (*i e*, fifty-two as compared with twenty-three) reflected the general tendency of most of the operators to await what they believed to have been complete subsidence of the inflammatory process

The cases can be divided into two sub-groups, as follows

(A) Those showing "acute cholecystitis" (unqualified), twenty-nine cases, or 55 plus per cent

(B) Those showing more severe acute lesions ranging from acute diffuse inflammation to empyema, gangrene, and perforation, twenty-three cases, or 44 plus per cent

TABLE IV

Pathological Diagnoses in 52 Cases of Proven Acute Cholecystitis in Which Complete Subsidence of Clinical Manifestations Had Occurred Prior to the Time of Operation (Group II)

Pathological Diagnosis	Number of Cases
<i>Sub-group A</i>	
Acute inflammation	29 cases, 55+%
<i>Sub-group B</i>	
Acute diffuse inflammation	2 cases
Acute inflammation with acute pericholecystitis	2 cases
Acute inflammation with empyema	2 cases
Acute inflammation with empyema and perforation	1 case
Acute inflammation with mural abscess	3 cases
Hæmorrhagic inflammation	4 cases

TABLE IV *Continued*

Ulcerative inflammation	2 cases
Ulcerative inflammation with empyema	1 case
Phlegmonous inflammation with empyema	1 case
Suppurative inflammation with perforation	1 case
Suppurative inflammation with pericholecystic abscess	1 case
Suppurative inflammation with mural abscess	1 case
Suppurative and hæmorrhagic inflammation	1 case
Gangrenous inflammation	1 case
<hr/>	
	23 cases, 44+%

Total number of cases—52

In none of the cases of Group II were there manifestations, at the time of operation, which are usually associated with acute cholecystitis, such as severe pain, tenderness, rigidity, vomiting, palpable mass or jaundice. While on many of the charts, there were no notes concerning the physical findings immediately preceding operation, it was found that in these the nurse's charts stated that the patients had no subjective complaints. In other words, all patients were free of symptoms referable to their disease, while in addition in many of the cases the physical examinations performed immediately prior to operation were essentially negative. Our later discussion will deal with sub-group A of Group I and sub-group A of Group II as one unit, and with sub-group B of Group I and sub-group B of Group II as a second unit. Any error which may therefore have occurred in the classification of a border-line case is minimized.

Examination of Table V reveals the fact that in forty-three of the fifty-two cases, the temperature was 99° or less. In four it was 99.4°, in three it was 99.6°, and in two it was 99.8°. In forty-three cases, the pulse rates were 84 or less. In four they were 86, in four they were 88, and in one it was 90.

TABLE V

Temperature and Pulse Rate in 52 Cases of Proven Acute Cholecystitis in Which Complete Subsidence of Clinical Manifestations Had Occurred Prior to the Time of Operation (Group II)

Pathological Diagnosis	No of Cases	Temp	Pulse
<i>Sub-group A</i>			
Acute inflammation	25	98.6-99°	23 cases 72-80
	2	99.4	3 cases 84
	1	99.6	2 cases 88
	1	99.8	1 case 90
	—		
	29		
<i>Sub-group B</i>			
Acute diffuse	2	98.6	64
		98.6	80
Acute with acute pericholecystitis	2	98.6	72
		98.6	84

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TABLE V *Continued*

Acute with empyema	2	98	80
		98 6	76
Acute with empyema and perforation	1	98 6	88
Acute with mural abscess	3	98 6	86
		98 6	76
		99 0	80
Hæmorrhagic	4	98 6	80
		99 6	84
		99 4	78
		99 6	86
Ulcerative	2	99 4	86
		99 8	84
Ulcerative with empyema	1	98 6	86
Phlegmonous with empyema	1	98 6	70
Suppurative with perforation	1	99	88
Suppurative with pericholecystitic abscess	1	98 6	80
Suppurative with mural abscess	1	98 6	80
Suppurative and hæmorrhagic	1	99 4	80
Gangrenous	1	99	84
	—		
	23		

Total number of cases—52

The acute manifestations had been absent for periods of from one to thirty-five days before operation. Table VI lists the number of days after the subsidence of acute manifestations that operation was performed, and the pathological findings in each case. In one case the patient had been free of acute manifestations since the last attack, three years previously. She was operated upon because of chronic digestive symptoms, after an X-ray of the gall-bladder had revealed the presence of stones. The pre-operative diagnoses included such terms as subsided acute, subsiding acute, and chronic cholecystitis.

General Discussion—It is to be noted that 44 plus per cent of the cases in Group II (absent manifestation group) showed advanced lesions on microscopical examination as compared with 82.6 per cent of the cases in Group I (minimal manifestation group). (See Tables I and IV.) These figures are in keeping with the general concept that the more marked the clinical manifestations, the more apt are advanced lesions to be present at the time of operation. Examination of Tables III and VI reveals that the pathological findings in identical time-groups vary considerably, and that the nature of the residual manifestations (whether mild or absent) gives no clue as to the severity of the lesion found in any given case at operation.

A study of the hospital charts of the twenty-three cases in Group I (minimal manifestation group) led to the classification of twelve as mild or moderately severe, while eleven could be classified as very severe at the height of the attack. Of the fifty-two cases in Group II (absent manifestation group), sixteen were classified as mild and thirty-six as severe at the height of the attack. It was noted that the lesions found on microscopical

TABLE VI
Number of Days of Absent Clinical Manifestations Between Subsidence of Acute Attack and Time of Operation (Group II) Pathological Findings in 52 Cases

1 day	2-4 days	5-7 days	8-10 days	11-14 days	15-21 days	21 days or longer
Acute	1 Acute	11 Acute	3 Acute	4 Acute	2 Acute	4 Acute
	<i>Sub-group A</i>					
	<i>Sub-group B</i>					
Hæmorrhagic	1 Acute diffuse	1 Acute diffuse	1 Acute with mural abscess	Hæmorrhagic	1 Acute with mural abscess	Ulcerative with empyema
		Acute with empyema	Suppurative with mural abscess			Suppurative with pericholecystic abscess
	Ulcerative	1 Hæmorrhagic	2			1 Acute with empyema and perforation
	Acute with pericholecystitis	2 Phlegmonous with empyema	1			Longest interval three years
	Suppurative and hæmorrhagic	1 Suppurative with perforation	1			
	Gangrenous	1 Ulcerative	1			
	—	—	—	—	—	—
	2	17	11	7	3	5
Total number of cases—52						

examination varied greatly and bore no consistent relationship to the severity of the clinical manifestations at the height of the attack. In other words, patients in whom the attack at its height could be classified as mild or moderately severe showed lesions ranging from acute inflammation (unqualified) to gangrene with perforation, while patients in whom the attack could be classified as very severe showed the same variations in the extent and severity of their lesions.

Consideration is now given the four cases with minimal manifestations and the twenty-nine cases with absent manifestations at the time of operation, that showed "acute inflammation" (unqualified). The former are of no unusual significance, and the minimal clinical manifestations at the time of operation are entirely compatible with the operative findings. These are the cases which one would properly classify as subsiding. If not actually subsiding at the time of operation they are assuredly capable of subsiding, since the pathological changes are not advanced. The remaining twenty-nine cases are of interest because they demonstrate that acute changes may exist in the gall-bladder of a patient who at the time of operation is free of subjective complaints and clinical manifestations. Since the manifestations were more severe at some previous time, it is fair to assume that in these cases the inflammatory lesions in all probability were also subsiding. Considering for a moment the entire thirty-three cases it is to be noted that the pathological lesions found in the absent-manifestation and subsiding-manifestation groups were identical, *i e*, "acute inflammation" (unqualified). Why some of the patients should exhibit minimal manifestations and others be free of manifestations in the presence of identical pathological lesions cannot be answered. Why this general group should have absent or minimal manifestations, as compared with the usual variety which exhibits severe manifestations in the presence of identical pathological findings, is also inexplicable.

There are now to be considered the nineteen cases with minimal manifestations and the twenty-three cases with absent manifestations at the time of operation that showed severe pathological changes, *i e*, hæmorrhagic, phlegmonous, suppurative, and gangrenous inflammation, empyema, perforation and pericholecystic abscess. The former (nineteen cases) are of considerable interest since they demonstrate that advanced inflammatory lesions may and do exist in the presence of manifestations that became minimal prior to the time of operation, after being marked at the height of an attack. The remaining twenty-three cases are outstanding, in so far as the operative and pathological findings paralleled those of the aforementioned nineteen, while the clinical manifestations were not only less, but absent. Both of the groups re-emphasize the fact that there are exceptions to the rule that the severity of the clinical manifestations is an indication of the severity of the pathological process. *In other words advanced grades of inflammation may exist in the complete absence of clinical signs and symptoms at the time of operation, or the presence of minimal clinical signs and symptoms at the time of operation.*

It is impossible to state with certainty whether the process in any given case of these forty-two was subsiding or progressive at the time of operation. Whether or not subsidence would have occurred likewise cannot be stated, as operation ended the opportunity for further observation. In spite of the marked pathological changes present, however, one may assume that most of the cases were at least capable of subsiding.

In eleven of the forty-two cases, the diagnosis of "gangrenous cholecystitis" was made on pathological examination. In each of the cases, the gangrenous process had diffusely involved the gall-bladder wall. When gross gangrene supervenes, the pathological process may be considered to be irreversible and to definitely preclude the possibility of subsidence. Progression of the process in the eleven cases was therefore the only possibility. An analysis of our figures shows that of the cases with advanced lesions, gangrenous cholecystitis was reported in ten (52.6 per cent) of the group of nineteen that had minimal manifestations, as compared with only one (4.3 per cent) of the group of twenty-three that had absent manifestations.

In addition four cases without gangrene, of the forty-two showing advanced lesions, were associated with pericholecystitic abscesses of large size. Three occurred in the minimal-manifestation group and one in the absent-manifestation group. These large pericholecystitic abscesses often do not absorb, especially if stones are present. Instead they become walled-off by dense organized exudate and may persist for long periods of time, unless free drainage occurs through the establishment of a communication back into the gall-bladder in the presence of a patent cystic duct. Drainage may also occasionally occur as the result of perforation into an adjacent hollow viscus such as the duodenum, stomach, or occasionally the colon. Small pericholecystitic abscesses may of course absorb spontaneously, as do abscesses of small size elsewhere. An abscess of fair size therefore constitutes a lesion which is usually persistent and at the same time locally active, rather than one which is subsiding. These lesions at some later time may occasionally disappear as the result of spontaneous drainage as described above, or may become progressive if a flare-up of the low-grade infection occurs.

Zinninger² states that "when empyema of the gall-bladder once develops it is unlikely to subside spontaneously, and may progress to gangrene and rupture of the wall." Although this statement may be true, we have purposely refrained from classifying as progressive, nine cases in this series that had empyema without actual gangrene of the gall-bladder wall. In short, regardless of the potentiality of a case to become progressive we have purposefully designated as progressive lesions only those that were actually irreversible at the time of operation. We therefore have considered only the eleven cases with gangrene and the four cases with good-sized pericholecystitic abscesses to have had non-subsiding lesions. A study of these fifteen cases reveals that thirteen had minimal clinical manifestations, while only two had absent manifestations. The thirteen cases constitute 68.4 per cent

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of the former group, while the two cases constitute only 8.7 per cent of the latter group

The fifteen cases represent, also, 20 per cent of the entire group of seventy-five under consideration. It is to be re-emphasized that this statement does not mean that 20 per cent of all cases of apparently subsiding or subsided acute cholecystitis have progressive lesions. It means that of a series of seventy-five cases of *proven acute cholecystitis in the presence of minimal or absent clinical manifestations*, 20 per cent, had progressive lesions, while the remaining 80 per cent had lesions that were subsiding or were considered capable of subsidence.

SUMMARY

(1) Four hundred twenty-nine operated cases of cholecystitis were reviewed. Of these, a special group of seventy-five with acute cholecystitis proven by pathological examination, that were found to have had minimal or absent clinical manifestations at the time of operation, were studied.

(2) Of twenty-three cases that had minimal clinical manifestations at the time of operation:

(a) 17.4 per cent showed "acute cholecystitis" on pathological examination, and

(b) 82.6 per cent showed more advanced acute lesions.

(3) Of fifty-two cases without clinical manifestations at the time of operation:

(a) 55 plus per cent showed "acute cholecystitis" on pathological examination, and

(b) 44 plus per cent showed more advanced acute lesions.

(4) Clinical manifestations were minimal or absent for from one to thirty-five days prior to the time of operation. In one case the patient was free of acute symptoms for three years preceding operation.

(5) The percentage of advanced pathological lesions was 82.6 in the group that had minimal clinical manifestations at the time of operation, as compared with 44 plus in the group with absent manifestations at the time of operation.

(6) The percentage of progressive pathological lesions was 68.4 in the group that had minimal clinical manifestations at the time of operation, as compared with 8.7 in the group with absent manifestations at the time of operation.

(7) In any given case, the severity of the attack bore no consistent relationship to the severity of the lesion found in the gall-bladder at operation.

(8) In any given case, the duration and nature of the residual manifestations, if any, bore no consistent relationship to the severity of the lesion found in the gall-bladder at operation.

(9) Twenty per cent of the cases in the entire series were considered to have progressive lesions, while 80 per cent were apparently either going on to subsidence or were considered capable of subsidence.

On the basis of this study, certain conclusions are warranted in regard to the clinical management and indications for operation *in cases of acute cholecystitis in which the clinical manifestations have subsided or are subsiding*. We may in general conclude that if the signs and symptoms are subsiding uninterruptedly, fairly promptly, and completely, there is no indication for *urgent* surgical intervention. On the other hand, because of the possibility (even though slight) of the existence of an advanced lesion, we feel that these patients should be operated upon within a short period of time after subsidence has occurred. Since nothing is to be gained by delay and in some cases much may be lost if perchance a progressive lesion is present, it has been the practice of the members of this service to operate within several days of subsidence, if in general no contra-indications to surgical therapy exist.

On the other hand, once subsidence has begun, if clinical manifestations persist even though they be slight, we feel that fairly prompt operation is indicated. Muscular rigidity, spontaneous pain, tenderness, a palpable mass, and fever if recrudescient or persistent even though not marked, are considered to be of great significance. Furthermore, the presence of an irregular tender mass even of small size strongly suggests the possibility of a pericholecystic abscess. White blood-cell and differential counts when high are confirmatory, but when only slightly elevated or normal do not militate against the diagnosis of a progressive lesion. After the first phase of infection has subsided and clinical manifestations have become slight or absent, blood counts often are apt to be unreliable as indicators of the severity and extent of the inflammatory lesion present. We therefore prefer to place our reliance in the later phases of infection on clinical signs and symptoms in deciding on indications for surgical intervention.

Since adopting the plan of treatment described above, we have on not a few occasions encountered advanced and progressive lesions in the presence of subsiding and subsided clinical manifestations. Although our series is comparatively small at present, the results thus far obtained have warranted the continuation of treatment along the lines we have outlined.

CONCLUSIONS

(1) Acute inflammatory changes may exist in the gall-bladder of a patient with minimal or absent clinical manifestations at the time of operation.

(2) The pathological changes range from simple acute inflammation to hæmorrhagic, phlegmonous, suppurative, and gangrenous inflammation, empyema, perforation and pericholecystic abscess.

(3) In general, the patients with minimal manifestations at the time of operation show a considerably higher percentage of advanced and progressive lesions than the patients with absent manifestations at the time of operation.

(4) Eighty per cent of the lesions in a selected series of seventy-five cases were considered to be subsiding or capable of subsidence. The remaining 20 per cent were considered to be progressive in nature.

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(5) In any given case, it is impossible to determine the exact nature and extent of the inflammatory lesion before operation

(6) In cases of acute cholecystitis, if subsidence once begun does not proceed uninterruptedly, fairly promptly, and completely, early operation is indicated

(7) In cases of acute cholecystitis with subsided clinical manifestations, operation, early rather than late in the "interval," is indicated

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PERFORATION OF THE GALL-BLADDER *

By E L ELIASON, M D , AND CHARLES W McLAUGHLIN, M D
OF PHILADELPHIA, PA

PERFORATION of the gall-bladder is considered in surgical text-books to be a rather rare complication of biliary disease. That acutely inflamed gall-bladders do not perforate more frequently has been attributed to the excellent blood supply of the viscus, its tough fibromuscular coat and the action of the bile in reducing the virulence of the pathogenic organisms in the gall-bladder. On Surgical Service C of the Hospital of the University of Pennsylvania this complication has been encountered nine times in the past eleven years in 490 consecutive biliary admissions. The occurrence of this series of perforations led to a review of the subject and an analysis of our cases.

Karullon,¹ in a series of 6,114 consecutive autopsies, found gall-stones present in 572, three of these cases having succumbed to a perforation of the gall-bladder.

The following table shows the incidence of perforation of the gall-bladder in several large series of biliary cases reported by various authors (Table I).

From the accompanying table it is evident that perforation of the gall-bladder occurs in from 1 to 3 per cent of all cases of biliary disease. The incidence of this complication has not been generally appreciated in the past and warrants more careful consideration by all surgeons.

TABLE I

Incidence—Perforation of the Gall-Bladder

Author	Cases	Perforated		Operation		Mortality
		Gall-Bladder	Calculi	ectomy	ostomy	
Gosset	—	111	33%	—	—	52%
Georg	—	348	—	—	—	42%
Fifield	1,066	27 (2.5%)	26 (96%)	5	22	44%
Fisher and Mensung	300	4 (1.3%)	—	—	—	—
McWilliams	3,180	29 (.9%)	—	—	—	—
Alexander	1,000	20 (2.0%)	12 (60%)	6	14	35%
Mitchell	1,270	16 (1.2%)	11 (69%)	10	5	43%
Eliason and McLaughlin	500	9 (1.8%)	8 (89%)	1	8	11%

Although calculous cholecystitis is encountered in the female patient many times more frequently than in the male, perforation of the gall-bladder occurs in a higher relative proportion of male cases. In our series of nine cases, 44 per cent were males.

* Read before the joint meeting of the New York Surgical Society and the Philadelphia Academy of Surgery, Philadelphia, February 14, 1934.

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Perforation of the gall-bladder has been reported in patients ranging in age from early youth to eighty years. Power and Johnston⁵ reported the case of a child two and a half years of age with a perforated empyema of the gall-bladder secondary to an ascaris lumbricoides infection of the biliary tract. Most of the reported cases occurred in patients between fifty and sixty-five, the average of our group being 57.3 years.

In the majority of cases of perforated gall-bladder disease a definite history of previous attacks of cholecystitis may be elicited. Years ago Grant⁶ called attention to the importance of long-standing biliary disease as a predisposing factor in perforation of the gall-bladder. Alexander³ elicited a definite history of gall-stone colic in fifteen of his sixteen cases and Georg⁷ reported similar findings in twelve of his twenty cases. Gosset, *et al*⁸ found a history of gall-stone disease in 33 per cent of their collected series of 111 cases. In our series of nine cases, all but one had a history of previous acute attacks of cholecystitis varying in number from one to eight. A review of these cases revealed a history of biliary disease extending back from eighteen months to fifteen years, the average being six years before admission with a perforation. In four cases there was a history of jaundice with previous acute attacks.

Six of our nine cases were admitted directly to the surgical service with provisional diagnoses of acute surgical abdomens. The shortest duration of the present illness on admission was four days, the longest was ten months. With the exception of this one case in which the history went back for a period of months the average duration of the present illness was twenty days.

Severe right upper quadrant pain was the predominant symptom in five cases. In two of these, agonizing pain was also present in the epigastrium. In one case the pain was not relieved by $2\frac{1}{2}$ grains of morphine in an eighteen-hour period. Three cases complained of only moderate right upper quadrant pain on admission, while one had no pain. There was radiation of the pain to the right scapula in three cases. Persistent nausea and vomiting were prominent features in six of the nine patients while the remaining three gave a history of gaseous distention and anorexia.

TABLE II

Symptomatology—Perforation of the Gall-Bladder

Case	Previous History	Duration P I	Pain	Radiation of Pain	Nausea Vomiting	Chills	Icterus
1	5 yrs	42 da	sev	no	+	yes	—
2	1 mo	30 da	no	no	+	no	—
3	25 yrs	4 da	mod	no	0	no	+
4	18 mo	8 da	sev	yes	+	no	+
5	15 yrs	4 da	sev	no	+	no	—
6	5 yrs	30 da	mod	no	+	no	+
7	8 yrs	10 mo	mod	no	+	yes	+
8	9 yrs	8 wks	sev	yes	+	no	+
9	5 yrs	8 wks	mod	no	+	no	0

It is evident that very severe right upper quadrant pain with or without shoulder radiation, accompanied by persistent nausea and vomiting which does not promptly respond to palliative therapy should lead one to suspect acute disease (calculus) of the gall-bladder

The essential physical findings in this series of cases are listed in Table III

TABLE III
Physical Findings—Perforation of the Gall-Bladder

Case	Local tenderness	Palpable Mass	Temperature	Pulse	W B C
1	+	+	101	110	11,700
2	+	+	99	100	10,200
3	+	—	98	70	6,400
4	+	—	101	120	21,000
5	+	—	102	110	12,500
6	+	+	101	120	18,000
7	+	+	98	88	9,000
8	+	+	98	100	5,600
9	+	+	99	110	

On admission a definite palpable mass was found in six cases, while two of the remaining cases were so exquisitely tender that satisfactory palpation of the abdomen could not be carried out. None of the patients had the diffuse abdominal tenderness and rigidity commonly associated with a widespread or generalized peritonitis.

Rontgenological studies were carried out in five patients. Two were subjected to a gastro-intestinal series because of persistent vomiting. In one of these cases visible peristalsis had been observed on clinical examination. In both cases an X-ray diagnosis of pyloric obstruction was made, being attributed in one to gastric carcinoma. Although the same diagnosis was considered in the second case, the rontgenologist suggested a diagnosis of empyema of the gall-bladder with secondary gastric retention as a possibility. Graham-Cole tests were carried out in three cases, the gall-bladder failing to visualize in each instance. In two of these cases X-ray of the chest disclosed the presence of a fixed right diaphragm with haziness at the base of the right lung. This was interpreted as being due to fluid in the pleural cavity secondary to the subdiaphragmatic lesion.

A correct pre-operative diagnosis of a perforated gall-bladder is quite unusual as shown by a review of the reported cases in the literature. In those cases in which there is a widespread soiling of the peritoneum without localization of the lesion, diagnoses of perforated ulcer, ruptured appendix, and diffuse peritonitis of undetermined origin have been frequently made. In cases which remain localized, acute gall-bladder disease, empyema of the gall-bladder, pyloric obstruction, intestinal obstruction, and abdominal tumor of unknown origin are the most commonly listed diagnoses. Mitchell⁴ reports that before operation the correct diagnosis was made in but one of his series of sixteen cases. Georg⁷ states that none of his twenty cases

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were correctly diagnosed before operation although the gall-bladder was considered to be the diseased organ in ten. In our series of nine cases the pre-operative diagnoses were acute perforated cholecystitis, one, acute calculous cholecystitis, seven, pyloric obstruction, one. Associated pre-operative diagnoses were acute pancreatitis, one, stone in the common duct, two, and empyema of the gall-bladder, four.

A correct pre-operative diagnosis of perforation of the gall-bladder is not often made because such a diagnosis is seldom considered as one of the possibilities. As mentioned above, the teaching for so many years has been to the effect that acute gall-bladder disease rarely undergoes perforation, that one is apt to omit this possibility in making a differential diagnosis.

The essential operative findings in our series of cases are listed in Table IV.

TABLE IV
Operative Findings—Perforation of the Gall-Bladder

Case	Localized	Stones		Culture	Operation		Result
	Abscess	Cystic	Extra Cystic		ectomy	ostomy Drainage of Abscess	
1	yes	yes	yes	strep	—	yes	good
2	yes	yes	yes	sterile	—	yes	good
3	yes	yes	yes	no pus	yes	—	good
4	yes	yes	no	sterile	—	yes	good
5	yes	yes	yes	B a lacti	—	yes	good
6	yes	yes	yes	B a lacti	—	yes	good
7	none	no	yes	no pus	—	yes	good
8	yes	yes	no	sterile	—	yes	died
9	yes	no	no	staph colon	—	yes	good

In seven of our nine cases a localized abscess was present at operation, secondary to a perforated gall-bladder.

In this group of cases the most common site of perforation was found to be in the fundus of the gall-bladder. Only one case was encountered in which the gall-bladder had been partially successful in perforating directly into the intestinal tract. In this patient a circular gall-stone two centimetres in diameter had passed through the gall-bladder wall and was lodged within the meso of the hepatic colon without entering the lumen of this viscus. None of the cases observed had developed intestinal obstruction due to gall-stones. Mitchell⁴ states that when this complication occurs, 65 per cent of the obstructions are found in the ileum, 21 per cent in the duodenum and jejunum, 10 per cent at the ileo-cæcal valve and the remaining cases either in the sigmoid colon or at the pylorus. Bennett⁹ in a review of 3,064 collected cases of small bowel obstruction found only twenty-eight cases due to gall-stones and concluded that this was a rather rare complication.

As has been frequently stated, the essential requirements for the development of an empyema of the gall-bladder are the presence of pathogenic

organisms and an obstruction of the cystic duct, usually due to stone. The operative findings in this series of cases reaffirm this statement. In seven patients stones were present in the gall-bladder at operation and with but three exceptions were also found outside the gall-bladder. Alexander³ reports the presence of stones in 60 per cent of his twenty cases and Fifield² found calculi in 93 per cent of his group of twenty-eight cases. That a gall-bladder may become gangrenous and perforate without presence of stones, as a result of a thrombosis of the vessels supplying its walls, is borne out by numerous reports in the literature. Tongs¹⁰ has recently reported such a case in which the cystic duct was completely occluded by debris at operation, and although the gall-bladder was gangrenous, no stones were present.

In our cases the amount of pus removed from the abscess cavities varied from 60 cubic centimetres to 1,000 cubic centimetres. That extremely large abscesses may develop in association with a perforation of the gall-bladder is evidenced by Overholt's¹¹ report of one from which over 4,000 cubic centimetres of pus were removed at operation.

Cultures of the pus in seven of our cases did not disclose the presence of virulent organisms except in two instances. While the colon bacillus, streptococcus and staphylococcus are the usual organisms responsible for acute cholecystitis, it is well recognized that they are primarily localized within the gall-bladder walls and one might well expect to find the cultures of pus obtained at operation sterile, as is frequently the case.

Cholecystostomy with drainage of the abscess cavity was the operative procedure carried out in seven of the nine cases. In the other two cases in which the old healed perforations of the gall-bladder were evidenced by the presence of encysted gall-stones in the pericholecystic fat in one and in the meso of the hepatic colon in the other, choledochostomy for associated common duct calculi was performed in each and a cholecystectomy in one.

CASE I—J S, male, aged sixty, was admitted to the University Hospital complaining of recurrent attacks of upper abdominal pain, associated with jaundice. Two and one-half years before admission the patient had his first attack of epigastric pain associated with anorexia, distention and jaundice. He was then free from symptoms until four months prior to admission when a similar attack was experienced. Subsequently the attacks recurred at intervals of a month, each characterized by epigastric pain, distention and jaundice. On admission, the temperature, pulse and respiration were normal. The patient was well developed and nourished, there was no evidence of weight loss but definite icterus of the sclera and skin was noted. There was a slight tenderness deep in the right upper quadrant. No masses were palpable. *Diagnosis*—Calculous obstruction of the common duct. At operation a dense mass of adhesions was found in the right upper quadrant, involving all the structures in this region. Scattered over and adherent to the peritoneal surface of the duodenum, hepatic flexure, and the omentum in this area were a dozen or more small gall-stones of variable sizes. The gall-bladder, which was subacutely diseased, was removed. The common duct was opened and several calculi removed, after which a T-tube drain was installed. Two of the gall-stones were removed from the free peritoneal surface and sent to the laboratory for confirma-

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tion of their suspected nature. They were reported as gall-stones. The patient's convalescence was entirely uneventful and at the time of discharge from the hospital his wound was healed.

CASE II—R. J., male, aged fifty-seven, was admitted to the hospital complaining of upper right quadrant pain. For seven years he had been suffering with upper right quadrant pain associated with jaundice and vomiting. He had lost seventy pounds in weight during the last year. On admission the temperature, pulse, and respiration were normal. Examination showed a definitely jaundiced man with evidence of weight loss. There was slight tenderness with resistance in the right upper quadrant. No definite masses were palpable. White blood cells, 9,000, urine, negative, Wassermann, negative. Icteric index was 40. Graham-Cole test showed a non-functional gall-bladder. *Diagnosis*—Calculous obstruction of the common duct. At operation the colon and duodenum were found to be intimately adherent in the region of the gall-bladder. No gall-bladder could be definitely found, the structure having been evidently completely obliterated. One faceted stone the size of a hazelnut was removed from the common duct and a T-tube placed in this duct. Lodged in the meso of the hepatic flexure of the colon adjacent to the gall-bladder fossa, a circular, firm gall-stone 2.5 centimetres in diameter was found. It had not eroded into the lumen of the colon and was removed without opening this structure. Routine closure with drainage was done.

In this group of nine cases there was only one death. This patient succumbed twenty-four hours after operation from acute cardiac failure. The average number of hospital days was thirty-two. Six of the series have been entirely relieved since operation. One case was left with a persistent mucous fistula while a second returned some months after his first operation with a calculous common-duct obstruction which was successfully relieved at operation.

In the literature, opinions vary in regard to the correct way of handling of acute perforated gall-bladder when such a lesion is found at operation. Georg⁷ advises cholecystectomy as the operative procedure of choice and quotes Mayo and Courvoisier as concurring in this opinion. Fisher and Mensung¹² also advocate cholecystectomy in every case in which this procedure can possibly be carried out. They report the case of a fifty-three-year-old male upon whom they operated twice within a period of three months, a perforated gall-bladder being found each time. Cholecystectomy was performed the second time and the patient recovered.

The mortality in all the reported series is high and leaves much to be desired. Georg⁷ in a collected series of 348 cases found the mortality to be 42 per cent. Mitchell⁴ reports a mortality of 43 per cent, Gosset, *et al*,⁸ 52.5 per cent, Alexander,³ 58.3 per cent and Fifield,² 42.4 per cent. In this series of nine cases the mortality was 11 per cent. Judd and Phillips¹⁴ report a series of sixty-one cases of perforation of the gall-bladder. In all but two the peritonitis was definitely localized. Cholecystectomy was performed in forty-eight of the sixty-one, with five deaths, and cholecystostomy was done in thirteen with one death.

Obviously the conditions found at operation would influence the type of surgical procedure that could be carried out in a given case. In this series a definite localized abscess surrounding the gall-bladder was present

in seven cases. In these, drainage of the abscess cavity with cholecystostomy was the only procedure which could possibly have been undertaken from a technical standpoint and with safety to the patient. In the other two cases in which the perforations had healed at the time of operation, a cholecystectomy was carried out in one case while the common duct was drained in both. In this series no cases with widespread dissemination of bile through the peritoneal cavity or diffuse peritonitis were encountered. This probably accounts for the fact that in the entire series there was only one fatality.

Realizing that perforation of the gall-bladder is not the rare catastrophe that it was once considered to be, more emphasis may justly be placed upon the necessity of urging all patients with attacks of recurrent calculous cholecystitis to submit to cholecystectomy while their gall-bladder disease is quiescent. Much may also be accomplished toward lowering the high mortality in cases that have already perforated by arriving more promptly at a correct diagnosis. Delay on the part of both the patient and the attending physician probably is responsible for the loss of many patients with this complication each year. On the assumption that the severe biliary symptoms represent only another attack of acute cholecystitis which will subside as the preceding ones have done, these cases are permitted to progress beyond the point where operation can save them. The difficulty of ascertaining the extent of the pathological process affecting an acute gall-bladder by clinical examination has been recently emphasized by Mentzer.¹³ If all cases of severe recurrent cholecystitis which do not promptly subside under adequate palliative therapy within a reasonable time are considered as potential perforations of the gall-bladder, this high mortality will be materially reduced.

SUMMARY AND CONCLUSIONS

(1) Perforation of the gall-bladder occurs in from 1 to 3 per cent of all cases of biliary disease.

(2) Perforation usually occurs in patients who have had a long-standing history of chronic calculous cholecystitis.

(3) A correct diagnosis is rarely made before the patient is subjected to diagnostic laparotomy.

(4) Early operation is urged in all cases of acute cholecystitis which do not promptly subside under adequate palliative treatment.

(5) The operative procedure in each case is entirely dependent upon the nature of the lesion found at operation.

(6) The mortality of perforated gall-bladder disease is extremely high, ranging from 10 to 58 per cent.

(7) Unless there is a definite contra-indication, all cases with recurrent attacks of chronic calculous cholecystitis should be urged to submit to surgery during a quiescent period.

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ACUTE FREE PERFORATION OF THE GALL-BLADDER

By O W NIEMEIER, M D , F R C S (EDIN)

OF HAMILTON, CAN

THE prevailing conservative attitude on the part of surgeons in the treatment of acute diseases of the gall-bladder, as contrasted with that of early intervention in acute appendicitis, is based on the assumption that the great majority of the former will subside

The occurrence of a recent case of acute free perforation of the gall-bladder in my practice has led me to investigate this subject with results which I believe are of interest. I append below the history of this case of acute free perforation of the gall-bladder with operation and recovery

CASE REPORT—Mr C, aged fifty-seven years. *Previous Illness*—Eighteen years ago he began having attacks of colicky pain in the right hypochondrium, another attack occurred three years ago accompanied by jaundice, with which he was in bed about a week

Practical Illness—On September 16, 1933, developed severe pain in the right upper quadrant which radiated to the back and was followed by vomiting. This was diagnosed as biliary colic and morphia was given. When first seen by me on September 17, 1933, there was a tinge of icterus present. The temperature was 99.2°, pulse 80, and there was moderate tenderness in the right hypochondrium. On September 18, 1933, the pain became more severe, temperature rose to 101° and tenderness was more marked and diffuse with some muscular rigidity, suggesting a definite acute cholecystitis with some localized peritonitis. He was sent to the hospital and carried along on intravenous glucose in saline with nothing by mouth, in the hope that the condition would subside. His white blood cells on September 19, 1933, were 13,100 (polymorphonuclears 75 per cent) and his condition seemed to be improving, the pain and tenderness became somewhat less marked, and white blood cells on September 20, 1933, were 12,300. On September 20, 1933, about 5 P.M., he suddenly developed an agonizing pain accompanied by signs of shock with cold, clammy sweat, morphia gr ½ was necessary to control the pain and an intravenous of glucose in saline was given for shock. Generalized abdominal rigidity was evident by the next morning and, as shock had subsided, laparotomy was proceeded with on the diagnosis of perforation of the gall-bladder.

Operation—On opening the peritoneum free bile was found in large quantities and the gall-bladder was found collapsed and entirely free of any protective adhesions. There was a stone in Hartmann's pouch with a perforation near the neck of the organ. Cholecystostomy was done with removal of a cholesterol stone from the gall-bladder and two cigarette drains placed in Morrison's pouch.

Post-operative—There was considerable distention for a few days but this was controlled with pitressin and flatus was being expelled freely on the third day, fluids by mouth then being allowed gradually. His fistula persisted, and stools remained clay-colored and some obstruction of the common duct was considered probable. No exploration of the common duct was made at the time of the first operation as his condition precluded anything of this kind.

Second Operation—On December 7, 1933, the abdomen was again opened and the gall-bladder found to contain bile which could be expressed. The common duct was markedly dilated and a stone could be palpated just above the duodenum. The duct was opened and a soft, crumbly stone, the size of a hazelnut, removed and a T drain

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inserted, and the duct closed about this. The gall-bladder was not removed as it was thought that it might be of future use in establishing a cholecystogastrostomy later, if stricture of the duct should occur. The biliary fistula immediately closed on removal of the drain and the patient has been well and free from jaundice ever since.

Perforations of the gall-bladder may be subdivided into three groups

(1) Chronic perforations with the presence of a fistulous communication between the gall-bladder and some other viscus

(2) Subacute perforations where the perforated gall-bladder is surrounded by an abscess walled off by adhesions from the general peritoneal cavity

(3) Acute perforation of the gall-bladder into the free peritoneal cavity without protective adhesions, as illustrated by the case reported above

The literature would indicate that acute perforation of the gall-bladder is extremely rare and that the mortality is very high

Mitchell¹ reports sixteen cases, of which six were acute, in 1,270 gall-bladder operations, giving an incidence of 1.2 per cent for all varieties with a mortality of 50 per cent

Alexander² cites 1,000 cases of biliary disease with a somewhat higher incidence of twenty cases, or 2 per cent, twelve being of the subacute variety, and eight or, 8 per cent, being acute free perforations. The mortality in the subacute cases was 25 per cent and in the acute free perforations was 50 per cent

Judd³ in a recent article on this subject, reports sixty-one cases of perforation of the gall-bladder, fifty-nine being of the subacute type with walling-off adhesions and two being acute free perforations with a mortality of 50 per cent. Judd states that in seven of these cases of perforation there was a fistulous communication with some other viscus. He also mentions three fatal cases of acute free perforation who were too ill for operation, constituting a total of five cases of this type in all. In a personal communication Judd was kind enough to inform me that these statistics were based on a series of 9,446 gall-bladder operations, giving an incidence of acute free perforations of about 0.5 per cent. Judd stressed the fact that many of their cases come from a distance and the cases of acute free perforations being too ill to travel are operated on at home. Consequently he felt that his series might not give a true picture of the incidence of this condition.

I undertook to investigate the gall-bladder cases in the Hamilton General Hospital during the last three years and wish to acknowledge my indebtedness to Dr R. E. Nicholson for the statistical information recorded below.

In a review of 349 operations on the biliary tract at the Hamilton (Ont.) General Hospital we found eight cases of perforation of the gall-bladder classified as follows: Chronic perforation, two cases—one into duodenum, one into colon; subacute perforation, four cases; acute free perforation, two cases.

There were no deaths in this series. This gives a percentage of acute free perforation of 5.7 per cent. This is ten times the frequency reported by Judd.

CONCLUSIONS—The conclusions to be drawn regarding acute free perforation of the gall-bladder, I believe, are the following

- (1) This condition occurs comparatively rarely
- (2) It is of sufficient frequency, however to demand eternal vigilance in the delayed treatment of acute cholecystitis
- (3) The mortality is extremely high as usually reported, but it would appear from our series that prompt recognition and treatment might lower this considerably

While we realize that our series is comparatively small, it is representative of the work of the average general hospital. I hope that this will stimulate others working under similar conditions to compile statistics so that from these combined figures we may evaluate this condition in its true light

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ACUTE INFLAMMATION OF THE GALL-BLADDER, CONSERVATIVE OPERATIVE TREATMENT

BY MOSES BEHREND, M D

OF PHILADELPHIA, PA

TO BEGIN this paper on the morbidity and mortality of the subject under consideration is most uncommon. Let me state at the outset that the success of the ultimate outcome of a patient operated on depends largely on the judgment of the surgeon, this judgment is gained from experience. To a marked degree this is amplified in the treatment of acute inflammations of the gall-bladder. On account of the somewhat contradictory opinions reported and expressed at the last meeting of the American Surgical Association it seems fitting to review our work and tell why our mortality and morbidity have been less than with those advocating radical measures in the treatment of acute cholecystitis. In over twenty-seven months I⁴ have not had a death from the operation of cholecystectomy. This excludes all malignant conditions, and operations on the common duct for cancer of the head of the pancreas. But it does include all types of inflammatory conditions of the gall-bladder with and without adhesions, and the various types of congenital bands. The morbidity of cases operated on in the acute stage is far greater because two operations are usually necessary whereas if our treatment is followed one operation suffices usually without drainage of the field of operation, about which more will be said later. It has been my experience to witness death within twenty-four or forty-eight hours after operation on cases of acute empyema of the gall-bladder. Whether this is due to the release of a massive infection, or the opening of spaces for the entrance of infection, or a chemical death, has never been settled to my satisfaction. Cultures have not helped much because they are usually sterile. I take exception to the opinions expressed by Stone and Owings,¹ Walton, Kirschner *et al* namely that acute gall-bladder conditions should be operated upon as an emergency procedure. The tendency of this teaching will result in a far greater mortality than we have observed for the past few years. It will be an annihilating influence, especially if practiced universally by those not able to cope with the increased mechanical difficulties encountered at operation on acute cases. A mortality of 10 per cent was always the greatest argument used against operation by those treating the diseased gall-bladder medically. Each year our mortality has been reduced because conservative methods have been used by not subjecting the patient to immediate operation. I fear again for a higher mortality because of the wide circulation these papers will receive. A surgeon who operates immediately upon the inception of symptoms of empyema of the gall-bladder is only playing with death, if, however, the surgeon waits two, three or four days or longer then he is not taking the risks

of an immediate operation. The proper time for operation may vary with each case, some subsiding in a day or two, when it may be safe to operate, while in others the operation may have to be delayed for a week or ten days on account of the acuity of symptoms. The time for operation is gauged by the physical signs imparted to one's fingers on palpation of the right hypochondriac region, the temperature, and pulse. Wait until the pulse rate is reduced. If rigidity persists to a marked degree, operation should be delayed, but if there is subsidence in physical signs it is perfectly safe to operate. We are absolutely and unalterably opposed to immediate operation in cases of acute cholelithiasis and acute empyema. Properly to handle these cases it is absolutely necessary to hospitalize them at once, where a careful and strict regimen can be instituted. Absolute withdrawal of food and drink are essential so that the intestinal tract is put at rest. Just enough morphine is given to control the pain. Five hundred to 1,000 cubic centimetres of 10 per cent glucose are given intravenously, 5 per cent by hypodermoclysis to prevent dehydration and also to maintain the glycogen reserve in the liver. Water by mouth is permitted in twenty-four to forty-eight hours provided the symptoms subside. In addition, daily infusion of glucose is given even after the symptoms have subsided because the reserve stored up by the administration of glucose cannot be overestimated. Calcium has been found of practically no use in the preparation of these cases and therefore has been discontinued. Blood transfusions are substituted and given whenever necessary.

Perforation of the Gall-bladder —Mentzer believes in immediate surgical intervention. He has shown from statistics taken from the literature that eight cases died while treated medically, that thirty-one perforated while being watched. The danger of perforation of the gall-bladder due to waiting for symptoms to subside is somewhat overestimated. Perforation of the gall-bladder in my experience is a rather rare complication. It cannot occur if the case is under absolute control of the surgeon and this can really be obtained only if the case is hospitalized and the treatment as outlined in the previous paragraph is strictly adhered to. The surgeon must be absolutely firm in insisting upon abstinence from any food, including water. If, however, the patient chooses to stay at home, surrounded by sympathetic family and friends, food and drink will be given with the consequent danger of complications. Physical and physiological rest are essential as a preventive to a perforated gall-bladder. In over twenty-five years of active surgical experience I have observed one perforation in a newly formed gall-bladder following the operation of cholecystectomy. In this case the gall-bladder was as large as the original gall-bladder except that the characteristics of the normal mucosa were absent. The patient recovered.

Anæsthesia —Spinal anæsthesia has been a great help in reducing morbidity and mortality in operations on the gall-bladder. There is no one factor that has contributed more to the ultimate recovery of the patient than that of spinal anæsthesia. Since using it I have not experienced any of the so-called chemical deaths following cholecystectomy which I believe are in a measure

due to the rough handling of the liver occasioned by rigid abdominal walls, and possibly the toxic effects of the anæsthetic on the liver. The relaxation induced by spinal anæsthesia allows one to manipulate the field of operation carefully, the dissection of the ducts and blood-vessels is facilitated more readily if one performs the so-called "open operation." By this I mean the visualization of the field in the region of the foramen of Winslow by opening the right free border of the gastrohepatic omentum. One must be careful after this is done that the cystic duct is separated from the common duct because with the relaxation due to spinal anæsthesia, ligation and destruction of the common duct can easily follow. There is nothing in the whole realm of surgery more embarrassing than the ligation and excision of this structure.

Drainage—Drainage of the field of operation after cholecystectomy is unnecessary in 98 per cent of the cases. Our guide for not using drainage is a field clear of blood, oozing and the escape of bile. The convalescence is easier, there is less disturbance due to nausea, and gas symptoms are few. The danger of hernia is practically eliminated on account of the omission of drainage and the use of spinal anæsthesia. Not one case undrained had to be reopened for a secondary collection, in fact, the only cases that required re-operation for a subhepatic or subphrenic abscess were those cases that were drained. In my monograph on the subject of gall-bladder I advocated drainage in every case. For several years now I have practically stopped its use, with better results.

Secondary Operations—Secondary operations should be avoided whenever possible. Cases of acute empyema of the gall-bladder usually require two operations because at the first operation the gall-bladder is drained, leaving a diseased structure that may cause considerable trouble. Secondary operations a few weeks after the primary operation are more dangerous on account of the adhesions which form quickly in all upper abdominal work. If we allow the symptoms to subside a primary cholecystectomy can be performed without danger.

Review of Literature—H. B. Stone and J. C. Owings,¹ it seems, have the best results from the immediate operation. They are dogmatic concerning the best way to handle the acute cases. They mention many authorities for and against immediate operation. Their mortality is not mentioned but they quote Mentzer who reported 33 per cent died as a result of late operation, while 19 per cent died as a result of early operation. Zininger is not able to judge which recover or which grow worse. He states 66 per cent died after waiting five days for delayed operation and 25 per cent died after immediate operation.

Morris K. Smith² is against immediate operation because of an unfortunate death occurring forty-eight hours after a partial cholecystectomy. This again confirms my observation, that a complete operation cannot always be performed in acute cases on account of the intense inflammation encountered especially at the cystic duct. A second operation for overlooked stones lurking in the piece of remaining gall-bladder, or for a persistent fistula, thus

becomes imperative. Smith quotes statistics from mortality records of cases of acute gall-bladders operated upon. Miller had 13.5 per cent, Whipple 13.7 per cent, H. F. Graham 6 per cent, and Zininger 7.8 per cent mortality. Out of 1,053 cases operated on, the mortality in acute cases was 9.3 per cent and the subsided ones 5.3 per cent.

While Judd and Phillips³ believe in early operations, they admit that not every case should be operated on at once. This I believe will be subscribed to by all surgeons except a radical few. Each case must be treated individually on its own merits. According to Love the mortality in operating on acute gall-bladder is 21 per cent. Love states that one of the dangers of allowing the case to subside is that the patient may leave without operation. This is true, yet it has also been my experience that symptoms will return sooner or later, when the patient is only too willing to undergo operation. The greater danger, to my mind, is the mistake in diagnosis that may occur, confusing the acute gall-bladder with a high appendix, perforated ulcer, and acute pancreatitis. This is plausible but with careful observation I believe the alert surgeon will soon apply the proper remedy, whether that be a waiting policy or immediate operation. Only recently a patient presented himself in the Philadelphia General Hospital with upper abdominal symptoms after being sick at home two days. We observed him for a few hours. The symptoms did not subside, operation was advised, acute pancreatitis was found. In a discussion following the aforesaid papers, Finney summed up the situation cryptically when he said that "one cannot be absolutely dogmatic in any surgical question. One should always exercise surgical judgment and be guided by it."

Harvey Smith,⁵ in a paper read before the Medical Society of the State of Pennsylvania, reported a mortality of 10 per cent, eight out of forty-eight cases of acute gall-bladders operated upon.

Many more references could be given to show that the mortality is greater after operation on acute conditions of the gall-bladder but there can be no better indictment against the immediate operation than the quoted statistics.

Citation of Cases—A recital of a few cases will help to substantiate the points I wish to make. About four years ago a prominent surgeon from Pennsylvania consulted me for symptoms referable to the upper right abdomen. A diagnosis of empyema of the gall-bladder was made. He wanted me to operate on him at once, which I refused to do. His persistence, however, prevailed upon my better judgment, the operation being performed before the subsidence of symptoms. In this case drainage was used. He lived four days following operation, death being due to a profound toxæmia.

A young woman suffering from acute cholecystitis, with a stone in the cystic duct, was seen in consultation. Curiously enough these cases usually have a single cholesterol stone blocking the duct. Since I was leaving for my vacation the following day, the family physician implored me to operate immediately. This was done next morning. She lived twenty-four hours following a high temperature, resembling the fatal cases due to a chemical intoxication.

An interesting case was operated on recently in two stages, three months intervening between operations. The patient never had any symptoms of gall-bladder disease until he suffered an attack of influenza four weeks prior to the acute gall-bladder symp-

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toms He was unconscious when taken to the operating room He was operated on in bed under local anæsthesia because of his huge physique, and the fear that too much handling of the patient would be detrimental to his recovery A diagnosis of a sub-phrenic collection, and empyema of the gall-bladder was made A lateral incision was made, a rib resected and the subphrenic space was drained Believing that this was not the sole source of trouble, the incision was continued over the abdomen and the acutely inflamed gall-bladder exposed to the "side-door" route The gall-bladder was drained and much pus was obtained Quite against our expectations the patient recovered, he was able to leave the hospital, and returned for a cholecystectomy which was performed through the original incision three months after the first operation This case illustrates how an acutely inflamed gall-bladder can cause a profound toxæmia The patient made a fine recovery

A woman was admitted with symptoms of acute gall-bladder disease, in addition she had some myocardial degeneration, a not-infrequent accompaniment of biliary tract disease She was not operated on until a month after admission to the hospital The gall-bladder was then removed with ease She recovered from operation, although her pulse was never under 100

A perplexing problem often presents itself in the pregnant woman The same waiting policy is followed One case was pregnant six months with symptoms of empyema of the gall-bladder After subsidence of symptoms she was operated on and made a good recovery She did not abort Another woman one week before delivery had severe symptoms of acute cholecystitis We waited for two weeks after labor before removing the gall-bladder Her convalescence was uneventful

Primary Plans—Finally, there is no question in my mind that, as a result of immediate operations on acute conditions of the gall-bladder, the mortality will be higher

The waiting period must vary because some patients respond to treatment more readily than others Depending on the case, operation can be performed in two days to two weeks or more with greater safety

Absolute abstinence from food or drink must be strictly enforced I have yet to see an acutely inflamed gall-bladder fail to respond to this treatment Glucose by all methods must be used, before and after operation The glycogen reserve must always be maintained Perforation need never be feared if this treatment is followed That we have not had a death from cholecystectomy in over twenty-seven months is largely due to the use of spinal anæsthesia Statistics prove that the mortality is greater after early, immediate, or emergency operations for acute cholecystitis

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PRIMARY CARCINOMA OF THE COMMON BILE-DUCT*

BY WALTER ESTELL LEE, M D , AND H P TOTTEN, M D

OF PHILADELPHIA, PA

OF LOS ANGELES, CALIF

FROM THE SURGICAL SERVICE AND THE PATHOLOGICAL DEPARTMENT OF THE GRADUATE HOSPITAL OF
THE UNIVERSITY OF PENNSYLVANIA

PRIMARY carcinoma of the common bile-duct presents a difficult clinical problem. As new growths in this location early interfere with the function of the duct by partially or completely occluding its lumen, giving rise to definite clinical manifestations while the growth is yet localized, one might suppose surgical intervention would be especially favorable for this type of neoplasm. There are, however, certain inherent difficulties in the diagnosis and treatment of these cases which tend to make the prognosis unfavorable and a study of the reported cases shows that the surgical results in this type of malignancy have not been encouraging.

Renshaw¹ reports a series of twenty cases from The Mayo Clinic covering a period of seventeen years with an operative mortality of 33.3 per cent. The average post-operative length of life of thirteen patients of the series was a little more than five months. Of eighteen operations, four were radical, three were exploratory and eleven palliative.

In Wahl's² six cases of carcinoma of the biliary tract, four were in the extrahepatic biliary ducts exclusive of the gall-bladder and all died shortly after operation, of complications the result of biliary obstruction.

Springer³ mentions a case of carcinoma of the papilla of Vater in the service of Dr. A. V. Moschowitz at the Mount Sinai Hospital in which the tumor was removed by transduodenal circular excision. The patient died on the sixth post-operative day of hæmorrhage. However, he cites another case reported by Dr. DeWitt Stettin in which the patient was alive eight and one-half years after an operation of this type.

Cheney⁴ described a case of primary carcinoma of the common duct confined within the lumen of the duct which was operated upon and a cholecystoduodenostomy performed. The patient died a few days following the operation. The cause of death was not given.

Cibot⁵ reports the case of a male aged seventy-five years with jaundice of only a few days' duration. A pre-operative diagnosis of carcinoma at the head of the pancreas was made. At operation, a rounded mass was revealed beginning in the hepatic duct just proximal to the junction of the cystic and common ducts and extending into the common duct. A cholecystogastrostomy was done, which, of course, did not relieve the obstruction. The patient died about two weeks later. Bronchopneumonia and severe hæmorrhage were post-operative complications.

In the group of cases collected by Quenu in which radical operation was performed, there were twelve post-operative deaths.

Although primary carcinoma of the common bile-duct is a comparatively rare pathological entity, it should be given consideration as a possible cause of persistent obstructive jaundice in all cases occurring in patients past middle age.

It is with the view of emphasizing the particular difficulties involved in

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the diagnosis and treatment of common-duct obstruction due to primary carcinoma that the following two cases are reported

CASE I—(No 83467) E M, a white female, aged fifty-four, admitted to the Graduate Hospital March 15, 1930, with the history that three weeks before admission she developed generalized itching. In a few days she became jaundiced. The stools were clay colored and the urine dark. These symptoms persisted and were present on admission. She had had no pain at any time. She was an obese female who did not appear acutely ill. Skin and scleræ had a deep icteric hue and the body showed scattered purpuric spots. Edge of liver palpable 12 cm below the costal margin, smooth, rounded, no nodules felt. The spleen was palpable. No masses or areas of tenderness. X-ray studies of the gastro-intestinal tract revealed rapid emptying time of the stomach and duodenum, suggesting extrinsic irritation.

Laboratory Studies—Wassermann and Kahn negative, icterus index 120, van den Bergh direct immediate, indirect varied from 2.8 to 10.5, blood sugar 80 mg per 100 cc of blood, cholesterol 290 mg, urea nitrogen 13 mg, calcium 9 mg, urobilinogen 1.20 to 1.50. Coagulation time 5.5 min, bleeding time 2.5 min. Bromosulphthalein 2 mg, 30 min 40 per cent, 60 min 25 per cent. Erythrocytes 4,130,000, polymorphonuclears 63 per cent, small lymphocytes 37 per cent, platelets 408,000. Fragility test, hæmolysis began at 0.40 per cent, complete at 0.28 per cent. Urine negative. Stools negative for occult blood. Temperature and pulse range were normal.

The diagnostic possibilities were five: (1) catarrhal jaundice, (2) stone in common duct, (3) carcinoma of head of pancreas, (4) cancer, primary elsewhere, with secondary involvement of the liver and bile-ducts, (5) the clinical course of rapid, silent, persistent jaundice with a palpable liver edge that is not nodular, but smooth and rounded, was compatible with and suggestive of, carcinoma of the common bile-duct.

In view of these considerations, the patient was referred to the surgical service for operation to relieve the existing obstruction, which was performed April 4, 1930 under spinal anæsthesia. Upper right rectus incision. Gall-bladder was found shrunk and collapsed, and contained very little bile and no stones. A thickened fibrous area was felt in the common duct which extended from above the junction of the cystic and common ducts to well below this point in the common duct. The duct was opened by a longitudinal incision and a definitely strictured area was exposed which gave one the impression of scar tissue, the result of previous trauma or ulceration. There was no suggestion of tumor formation and the regional lymph-nodes were not visibly enlarged. Exploration of the entire duct with a probe toward both the duodenal and hepatic ends failed to demonstrate stones or other pathology. Assuming that the stricture was benign, a restoration of the lumen of the hepatic and common ducts was attempted with a No. 12 F soft rubber catheter. Two cigarette drains were introduced into Morrison's pouch and the abdominal wall was closed in layers about these drains.

Convalescence was smooth until the fifth post-operative day, when bleeding began. The dressings were saturated with blood and considerable blood was passed in the form of tarry stools. The coagulation time and bleeding time were within normal limits. Two hundred and fifty cc of a 5 per cent glucose solution were given intravenously every twelve hours and 10 cc of 5 per cent calcium chloride. Two transfusions of citrated blood were given. Cardiac failure threatened from the loss of blood volume and in addition to replenishing the fluid volume, large doses of tincture of digitalis were given. On the seventh post-operative day the hæmorrhage recurred to an alarming degree. Bleeding occurred freely from the abdominal wound and much blood was passed in the stools. The patient went into a state of shock. She was taken to the operating room and two deep mattress sutures were passed through the abdominal wall to control the hæmorrhage. A transfusion of 500 cc of citrated blood was given and 200 cc of normal saline. These measures apparently controlled the visible hæmorrhage and the patient recovered from the shock. However, bleeding persisted from the gastro-intestinal

tract She was again transfused with 500 cc of citrated blood and 200 cc of normal saline She failed to rally, however, and died shortly following the last transfusion

Pathological Notes—The autopsy was limited to the abdomen There was a considerable amount of bile-stained blood in the abdominal cavity Outside of the fact that all the tissues were bile-stained, the pathology was confined to the bile-duct, liver and pancreas Upon opening the common bile-duct, the catheter was seen to be in place The fibrous stricture in the duct extended from 1.5 cm above the junction of the cystic and common ducts to well below this level The wall of the stricture was 7 mm thick and 2 cm long Two fistulae were seen 1 cm proximal to the origin of the cystic duct, through which bile had escaped into the peritoneal cavity The leakage had occurred along the suture line The superior surface of the liver was adherent to the diaphragm by numerous adhesions, easily broken Pressure exerted upon the gall-bladder permitted bile to flow into the duodenum

Microscopical Diagnosis—Bile-duct Adeno-carcinoma and recent thrombosis Liver parenchymatous degeneration of cells, chronic passive congestion, perihepatitis Pancreas, chronic pancreatitis, hyperplasia of stroma

CASE II—(No 83898) A R A white female, aged forty-eight, admitted to the Graduate Hospital April 3, 1930, in the metabolic service of the late Dr O H Pettv She had had diabetes for the previous six months, but had not consistently adhered to diet or insulin treatment Seven weeks before admission she had an attack of nausea and vomiting accompanied by pain in the gall-bladder region which was referred to the right shoulder and back The pain lasted for two days She became jaundiced The jaundice gradually disappeared About three weeks later she had a similar attack which required a hypodermic of morphine for the relief of the pain The jaundice had persisted from that time, with recurring attacks of nausea and vomiting No recurrence of pain She had grown weaker and was losing weight rapidly On admission she was deeply jaundiced and greatly emaciated There was tenderness in the region of the gall-bladder No other organs or masses were palpable

Early operation was advised in order to relieve the obstructive jaundice as soon as possible The obstruction was considered particularly harmful in view of the diabetes

April 4, 1930, under spinal anæsthesia, the abdomen was opened through an upper right rectus incision All the organs and tissues of the abdominal cavity were deeply jaundiced The liver was greatly swollen, congested, the edges rounded and there was evidence of acute hepatitis The gall-bladder was enormously distended, its walls thickened and opaque The common and cystic ducts were carefully palpated, but no definite stone was felt The common duct was not distended The distended gall-bladder was opened and a perfectly clear liquid escaped A finger was then placed in the foremen of Winslow and the common and cystic ducts milked upward in an effort to palpate stones Immediately a purulent bile-stained fluid escaped from the opening in the fundus of the gall-bladder and with it a soft, muddy, black, gall-stone debris Most of the gall-stone debris was small, about the size of sand granules, although some of the pieces were as large as a French pea This milking process was repeated several times until no more gall-stone debris could be obtained A spoon eurette removed a number of pieces of gall-stones larger than previously found A probe was passed through the dilated cystic duct, into the common duct, toward both hepatic and duodenal ends without encountering resistance Although the common duct had been thoroughly palpated, no evidence of malignancy was discovered

The condition of the patient was such that any extended operation was considered inadvisable Drainage of the gall-bladder was decided upon with the hope of re-operating when the patient's condition had improved The exploration had been as thorough as could be done without opening the common duct or duodenum The post-operative course was very stormy Vomiting was frequent and difficult to control It was practically impossible to keep a duodenal tube in place Large amounts of fluids and glucose were administered by hypodermoclysis and intravenously to combat dehydration During

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the entire period the drainage through the cholecystostomy tube was free, so free in fact, that it seemed an obstruction in the common duct still existed. Bile drainage varied from 500 cc to 2,500 cc per twenty-four hours. During the period when there was an excessive loss of bile an attempt was made to return it by way of the duodenal tube. This was only partly successful because of the difficulty of retaining this tube in the duodenum. The bile then was given by proctoclysis. The patient remained markedly jaundiced throughout her illness.

In spite of all supportive measures the patient's condition rapidly declined and she died April 25, 1930, the twenty-first post-operative day. The autopsy was confined to the abdomen. Stomach Distended with fluid and gas. Duodenum The valvulæ conniventi prominent. This structure contained mucus. Around the papilla of Vater there was an ulcerated area with elevated edges. This surrounded the opening of the common duct and the duct of Wirsung. Obstruction had taken place, for both of these ducts were very much dilated. The common bile-duct was fully 1.5 cm in circumference and the pancreatic duct twice its normal size. *Diagnosis* Carcinoma involving the submucosa near the ampulla of Vater, chronic interstitial pancreatitis, cirrhosis of liver, hepatitis. Gall-bladder Small and contracted. There was an opening in the fundus through which it drained. The cystic duct was not dilated to any great extent, while the hepatic duct showed dilation.

The history of rapid onset of a progressive and finally complete jaundice with the physical findings in these two cases pointed rather strongly toward a malignancy although in the second case the history of two acute attacks of pain suggested the presence of gall-stones. However, it was considered possible for a neoplasm of the common duct to stimulate a stone by causing spasm of the duct with resultant acute attacks of biliary colic. The pre-operative diagnosis of malignancy causing obstruction made in both instances was changed at the operation to benign stricture, and cholelithiasis respectively, only to have the pre-operative diagnosis confirmed at autopsy. It is only fair to say, however, that in Case II, a more thorough investigation was impossible because of the patient's critical condition.

These cases emphasize in no uncertain manner the ease with which a small growth confined to the common duct may be mistaken or missed at operation. It leads one to suspect that many cases of primary malignancy of the common duct may be missed entirely unless the surgeon is particularly alert to detect them and makes a thorough exploration of the common duct by choledochotomy or transduodenal exploration of the papilla and ampulla in every suspicious case. Such cases may go entirely unrecorded unless they come to re-operation or autopsy.

It is important to realize, while exploring the common duct, that a strictured and fibrous area may harbor malignant cells without having the gross appearance of a tumor. This fact was well emphasized in our first case.

The cause of death in Case I was entirely due to post-operative hæmorrhage, incident to the biliary obstruction. It could as well have been due to biliary obstruction from any cause. The rapid and fatal termination after the onset of the hæmorrhagic state demonstrates conclusively that there is a certain type of post-operative hæmorrhagic diathesis following obstructive jaundice for which there is as yet no adequate treatment.

The coagulation time and bleeding time proved not only worthless but misleading as indices of the hæmorrhagic tendency. It is hoped that the sedimentation rate, as suggested by Linton,⁶ may prove of prognostic value in these cases.

The cause of death in the second case was grave metabolic disturbance, the result of diabetes, plus renal and hepatic insufficiency. The loss of large amounts of bile may have been a contributing factor to the metabolic upset, but this was in part compensated for by the re-administration of bile by tube. The biliary obstruction together with the renal and hepatic insufficiency made the diabetes especially malignant.

Etiology—That gall-stones and chronic cholecystitis constitute a pre-cancerous condition of the gall-bladder is generally held. Miller,⁷ in a study of operative and autopsy records of over 10,000 cases of gall-stones, found an incidence of 4.1 per cent of carcinomas. The relationship of gall-stones to cancer of the bile-ducts, however, does not appear to be direct. Gall-stones are more prevalent in the female, while cancer of the bile-duct is almost equally distributed with possibly a slight preponderance in the male. Infection or chronic irritation may be an etiological factor.

Symptoms—The possibility of primary carcinoma of the common bile-duct should be considered in all cases of obstructive jaundice which persist for over a period of two or three weeks in a patient at or past middle age.

The occurrence of biliary colic in obstructive jaundice does not necessarily rule out the chance of a primary malignancy being present. Gall-stones causing partial or complete obstruction may co-exist with a primary new growth. Also a new growth, by setting up an irritative spasm of the bile-duct, may cause acute biliary colic. There are several recorded cases of co-existing gall-stones and primary malignancy in which the clinical and operative findings led to a diagnosis of cholelithiasis, with the later finding of a tumor at re-operation, or autopsy. In the absence of biliary colic, a history such as the following is very suggestive, the development of a rapid, complete non-febrile jaundice in a person of about middle age, which has lasted long enough to exclude catarrhal jaundice, and associated with a certain amount of epigastric distress. Confirmatory physical findings will be the smooth rounded edge of the liver palpated a few centimetres below the costal margin and a palpable distended gall-bladder which is not tender.

Diagnosis—The diagnosis of biliary obstruction is not difficult. This is the important finding. An afebrile jaundice with high readings of the icterus index and van den Beigh, dark urine, clay-colored stools, an absence of urobilin in the urine and faeces, and an absence of bile in the duodenum makes the condition self-evident.

Early recognition as a surgical condition and early operation, with complete exploration is the only means of making certain the presence or absence of malignancy in early cases. Stones, as a rule, do not completely obstruct the common duct. Urobilin in the urine and faeces indicates that some bile passes into the duodenum. Analysis of duodenal contents will determine whether obstruction is complete or not. Tumors, on the other hand, are more apt to cause a complete obstruction. Rarely, jaundice may be absent during the entire time, as in the cases reported by Cabot⁵ and Walters.¹⁶ The possible co-existence of gall-stones and tumors should always be remembered. Courvoisier's law is not of any particular aid in making a diagnosis of the individual cases.

Prognosis—The prognosis, generally speaking, except for the complications resulting from biliary obstruction, should be better than for malignancies located elsewhere in the gastro-intestinal tract and associated organs because a growth here declares itself early, by mechanical blocking of the duct. When

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the growth is confined to the duct, the prognosis, in a large measure is dependent on the complications resulting from biliary obstruction and naturally the longer the jaundice has been present the poorer the prognosis will be

Pathology—The usual site of cancer of the common duct is either at the junction of the hepatic and cystic ducts, or near the duodenal termination of the common duct, where stagnation of bile or trauma are most apt to occur

Rolleston,⁸ in a study of 100 collected cases, found that one-third of all new growths of the bile-ducts arise in the lower terminal portion of the choledochus. The origin of new growths in this region may be from (1) common bile-duct, (2) ampulla of Vater, (3) duct of Wirsung, (4) papilla of Vater, (5) duodenal mucosa, (6) head of the pancreas. The most common type is a growth arising from the duodenal surface of the papilla of Vater. It usually takes the form of an eroded ulcer with a depressed centre, and over-hanging thickened carcinomatous walls. The distribution of Rolleston's 100 cases was: Common duct, forty-four, junction of the three ducts, twenty-seven, hepatic duct, twenty-two, and cystic duct, seven.

They occur usually in three forms, namely, (1) villous growths which may distend and fill the ducts, (2) nodular masses which tend to encroach upon and constrict the duct, (3) a diffuse growth along the duct which converts it into a firm tube. The usual form is adeno-carcinoma.

Rolleston⁹ believes the majority of carcinomas of the bile-ducts are derived from the surface epithelium although the spheroidal cell carcinoma may be derived from the mucous glands in its wall. An analysis of forty-three cases showed thirty-seven columnar, five spheroidal, and one colloidal in type.

Mucoid degeneration of the columnar cells, or transition from columnar to spheroidal cells may take place, and metaplasia may result in the formation of squamous-cell carcinomata. According to Ziegler,¹⁰ MacCallum¹¹ and Ewing,¹² carcinoma of the bile-ducts is usually of the columnar-cell type. Mayo Robson¹³ states that carcinoma at the head of the pancreas is spheroidal cell, while carcinoma of the ducts is almost always columnar in type.

The one striking gross pathological feature is that they are often seen in the early stage, because of the mechanical interference which they create, due to their strategic position, while they are yet so small as to be easily overlooked at operation or autopsy.

Benign tumors of the extrahepatic ducts are comparatively rare, Bazin¹⁴ reported a case of papilloma of the common duct in which successful excision of the tumor was done. He cites sixteen cases gathered from the literature, some of which are on the border-line of malignancy. He states that all papillomata are potentially malignant.

In a series of tumors of the bile-ducts, reported by Marshall,¹⁵ there were four benign, as compared to forty-nine malignant. These cases were gathered from operative material at The Mayo Clinic, extending over a period of twenty years, and comprising 23,000 operations on the biliary apparatus.

From this wealth of material the following observations are made:

- (1) Prevalence of carcinoma of the bile-ducts in patients past middle age
- (2) Prevalence in the male, 62 per cent
- (3) Relative low-grade malignancy of the tumor with considerable amount of fibrous tissue
- (4) The predominant tumor is adeno-carcinoma composed of columnar epithelium

(5) Hæmorrhage is the most common serious post-operative complication and the most common cause of death

From the practical standpoint the distinction between benign and malignant tumors of the common duct is more of academic than clinical interest, as on the one hand, the malignant growths are usually small, confined to the duct, slow-growing, and slow to metastasize, and on the other, the benign tumors are potentially malignant, and are often border-line

In both types mechanical interference is responsible for the disturbed chemical and physiological processes, expressing themselves clinically in hæmorrhage and cholæmia

Treatment—The pre-operative preparation consists of

(1) Administration of large amounts of easily assimilated carbohydrates to build up the glycogen reserve of the liver

(2) Adequate fluid intake of at least 3,000 cc of fluid daily This may be administered in the form of a salt solution by hypodermoclysis or infusion, if there is a tendency towards vomiting

(3) Calcium in some form, either as calcium chloride by vein, or as calcium lactate by mouth, should be given daily for a few days pre-operatively, in the effort to prevent the post-operative hæmorrhagic tendency, although recent studies would make it appear that a lack of available calcium is not a factor in the hæmorrhagic tendency in obstruction jaundice

(4) Transfusion of whole blood is indicated as a preparative measure when the hæmorrhagic tendency is manifested by purpuric spots or a rapid sedimentation rate is present

Operative Procedure—Spinal anæsthesia seems to be particularly well suited to this type of case, as it spares the liver the burden of a general anæsthetic and makes easy the exposure of the hepatic and common ducts with a minimum of trauma Palliative operations of cholecystostomy or cholecystenterostomy may be indicated when the lesion is below the level of the cystic duct, and is irremovable or where a more extensive and radical procedure is contemplated at a second operation after improvement of the patient's condition has taken place

Radical operation varies with the type of pathology existing A three-stage operation has been suggested by Kansch¹⁷ for tumors at the lower end of the common duct The first stage consists of a preliminary cholecystenterostomy to relieve the jaundice and improve the nutrition At the second stage, radical excision of the tumor is done Adjacent portions of the duodenum and head of the pancreas are resected if necessary with blind closure of the upper end of the duodenum, implantation of the ablated head of the pancreas, common bile and pancreatic ducts, into the lower end of the duodenum A gastroenterostomy is done at the third stage

Where the growth is strictly confined to the papilla, simple excision may be done through a transduodenal incision With the growth located higher

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in the duct, but below the cystic duct, excision of that portion with cholecystogastrostomy or cholecystenterostomy may be done

When the growth is at the level of the cystic duct or higher, resection of the involved portion with implantation of the hepatic duct into the stomach or duodenum is the procedure of choice, but considerable technical difficulty may be encountered

In the series reported by Renshaw,¹ resection of a portion of the duct with end-to-end union was done in one case, and resection of a portion of the wall with a plastic repair of the duct over a T-tube was done in another instance

Post-operatively prompt measures are indicated to support the liver metabolism by the use of glucose and fluids. Digitalis may be indicated for the circulation. Blood transfusions should be resorted to where a hæmorrhagic tendency is present. Calcium chloride and parathormone may be of some use. Re-introduction of bile by duodenal or rectal tube is indicated where bile loss is excessive. The continuous intravenous drip of 5 per cent glucose in Ringer's solution as advocated by Matas for various post-operative conditions should prove especially valuable in cases of obstructive jaundice complicated by hæmorrhage and hepatic insufficiency

CONCLUSIONS —(1) The symptoms of primary cancer of the common bile-duct are not pathognomonic. They may be suggestive but in final analysis they are simply the symptoms of mechanical biliary obstruction

(2) It is important to consider the possibility of a primary malignant growth in all cases of persisting obstructive jaundice in patients past middle life. The presence of one or more gall-stones in the common duct should not lead one to neglect a complete exploration of the ducts

(3) Early operation is urged with thorough and painstaking exploration of the common duct for possible malignancy in all suspicious cases

(4) The high mortality which attends operations for biliary obstruction due to primary cancer is due almost entirely to complications resulting from mechanical obstruction of the biliary tract

(5) Post-operative hæmorrhage following the relief of mechanical biliary obstruction is responsible for the high percentage of deaths

(6) Diabetes complicating complete biliary obstruction is particularly dangerous, due to grave metabolic disturbance

(7) Early diagnosis and early operation will tend to lower the mortality rate not only by minimizing the chance of extension of the primary growth, but by decreasing the incidence of complications due to obstructive jaundice, namely, hæmorrhage, hepatic insufficiency and cholæmia

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THE RONTGENOLOGICAL LOCALIZATION OF SPINAL SUBARACHNOID BLOCK BY THE USE OF AIR IN THE SUBARACHNOID SPACE

BY WILLIAM P. VAN WAGENEN, M.D.
OF ROCHESTER, N. Y.

FROM THE DEPARTMENT OF SURGERY, NEUROSURGICAL DIVISION, UNIVERSITY OF ROCHESTER

THE difficulty of determining, at times, the exact level of a subarachnoid block due to tumor and other lesions is too well known to warrant comment. The use of lipiodol or similar preparations has added greatly to the certainty of diagnoses both as to the site of such a block and, to a certain extent, its nature. Where the subarachnoid block is complete or nearly so, the roentgenological demonstration of a few cubic centimetres of air injected in the lumbar subarachnoid space will serve to denote the level of the lesion as well as lipiodol. The meningeal reaction following the injection of a few cubic centimetres of air is practically nil, and certainly far less than that following a lipiodol injection. It also has the advantage of being rapidly absorbed rather than acting as a foreign body for a period of months or longer.

A résumé of three typical case records is given where the exact level of the lesion seemed to be in doubt.

CASE REPORTS—CASE I—R. H. (Hosp. Case No. 18,306), male, age thirty-one, was admitted to the Strong Memorial Hospital because of "pain in the left kidney region."

Fifteen months prior to entry the patient had contracted an acute Neisserian infection of the urethra. This was followed by a severe prostatitis and cystitis. Some twelve months prior to entry he experienced urinary retention and from that time on catheterized himself at irregular intervals. A severe pyelitis evidently ensued with considerable backache, pain in the region of the left kidney, chills and fever. Because of this he was confined to another hospital for four months. At about the same time that urinary retention was noted a sense of burning, numbness, and pain of both lower extremities began. Weakness of both lower extremities was also noted. These symptoms progressed until he was barely able to walk or turn over in bed. At the time of entry he was emaciated and practically bedridden. The urinary tract was found to be badly infected. Bladder calculi added to the difficulty of treatment of the infection.

Neurological examination showed an indefinite sensory level at about the second lumbar segment. Knee and ankle jerks were absent. The cremaster reflexes were present. The plantar and anal reflexes were absent. A lumbar puncture showed a slightly xanthochromic fluid. The initial pressure was 52 millimetres of water. There was no rise in pressure on repeated jugular compression. Cell count was five. Pandy plus, Ross-Jones plus. A few well-crenated red cells could also be made out in the spinal fluid. Chloride determination was 695 milligrams per 100 cubic centimetres, sugar, 64 milligrams, non-protein nitrogen 18.7 milligrams. Six cubic centimetres of air were injected into the subarachnoid space after the fluid had been allowed to escape. X-rays taken with the patient in the sitting position showed the air shadow stopping at the level of the body of the second lumbar vertebra. (Fig. 1.)

After the urinary tract seemed to be as free of infection as it might become for some time, a laminectomy was performed. A large tumor ventral to the cauda equina was

found and removed. Pathologically it proved to be a tumor arising from the perineural sheath of one of the filaments of the cauda equina (Fig 2). The patient did well until the ninth post-operative day when he developed fever and other signs of meningitis. Death occurred three days later. Autopsy revealed a bilateral pyonephrosis, multiple renal abscesses, multiple vesical calculi with cystitis, and a generalized meningitis.

CASE II—H. F. (Hosp. Case No. 23,874), age, thirty-nine. Increasing numbness and pain in both lower extremities for two years, occasionally pain "between the shoulder



FIG. 1.—Reproduction of X-ray negative showing air in spinal subarachnoid space denoting lower level of subarachnoid block.

blades," and occasionally a sensation of numbness in the right middle finger were the principal complaints. He could barely walk even with the aid of canes. Both lower extremities were spastic. Deep reflexes were hyperactive. Ankle clonus and Babinski's sign were bilaterally positive. Superficial reflexes were absent except pharyngeal and corneal. The sensory level varied from time to time but was never recorded above that of the fifth thoracic segment.

A lumbar puncture showed the spinal fluid to be xanthochromic. Initial spinal-fluid pressure was 130 millimetres water, abdominal compression caused a rise to 190 millimetres water. Jugular compression resulted in no rise in the manometer. A diagnosis of a spinal-cord tumor was made.

DIAGNOSTIC USE AIR IN SUBARACHNOID SPACE

Because of the history of numbness of the right middle finger, a lesion at a higher level than dorsal five or the sensory level, was suspected. Consequently 6 cubic centimetres of air were injected into the lumbar subarachnoid space. Stereo A P X-rays were taken which showed the lower level of the subarachnoid block at the body of the second thoracic vertebra. In this instance the air shadow of the trachea overlay that in the subarachnoid space and could not be delimited except in stereo X-ray plates.

A laminectomy revealed a large extramedullary benign tumor (perineural fibrosar-

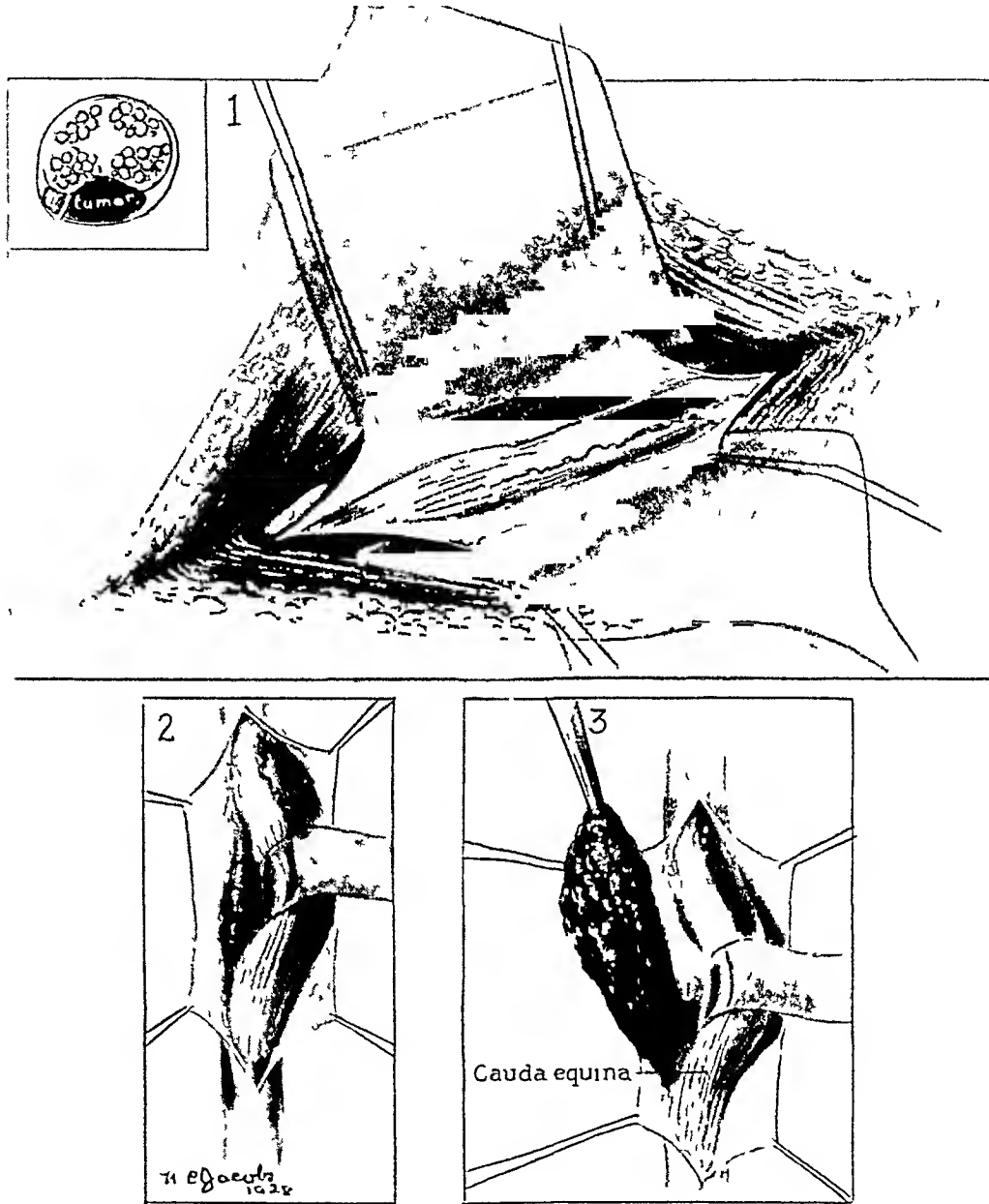


FIG 2—Artist's sketch of tumor removed at operation in Case I

toma) which was removed in toto (Fig 3). The patient has recovered sufficiently so that he can walk easily without canes although signs of permanent pyramidal tract damage persist.

CASE III—A S (Hosp Case No 50,026), age forty-three. The exact date of onset of the present illness may have dated back some ten years at which time the patient complained of a dull dragging pain in the left lower quadrant. Two and one half years ago pain in the left lumbar region radiating into the groin was complained of. A left nephrectomy was performed without relief of symptoms. Three months prior to entry

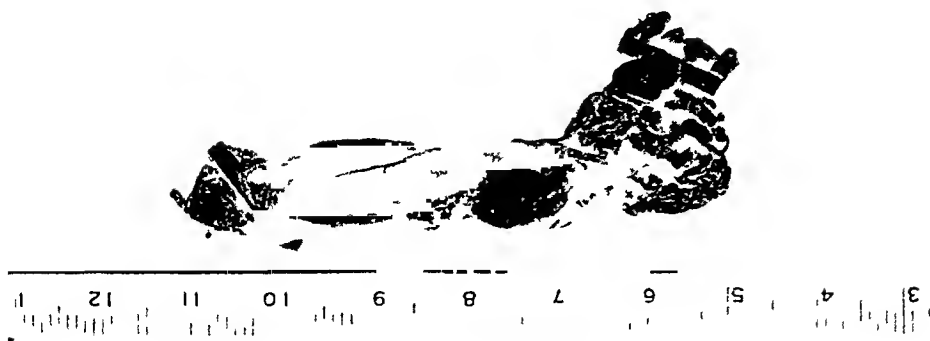


FIG 3—Photograph of tumor producing subarachnoid block in Case II



FIG 4—Reproduction of X ray negative showing air in the spinal subarachnoid space denoting the lower level of the subarachnoid block

loss of sphincter control was noted. When admitted she presented a nearly complete paraplegia. The sensory level was uncertain and variable. A lumbar puncture showed the spinal fluid to be xanthochromic. Pressure readings gave evidence of a complete spinal-fluid block. Six cubic centimetres of air were injected into the lumbar subarachnoid space. X-ray films taken showed the lower limit of the subarachnoid block to be at the level of thoracic 12 (Fig 4).

A laminectomy revealed a large, very vascular extramedullary tumor which had compressed the lower end of the cord into a ribbon-like structure. The intradural portion of the tumor measured some 5 by 6 by 2 centimetres. It was attached to the dura which was removed with it. The tumor was then seen to be of the collar-button type with an extension ventrally alongside of the body of the eleventh thoracic vertebra. This portion was not removed in as much as it seemed likely that the extent of cord compression was too great to hope for any relief of paraplegia. Histologically the tumor was a hæmangioendothelioma.

Method of taking X-ray films—All X-rays naturally must be taken with the patient in the sitting position. True lateral films of the spine are preferable to antero-posterior views. In the upper thoracic region stereo A P films may be taken if the shoulder-girdle structures obscure the spinal canal.

In two other instances of a complete spinal subarachnoid block air was injected into the lumbar sac to determine the site of the lesion. X-rays failed to demonstrate a collection of air in the spinal canal. Subsequent cisternal lipiodol injections revealed the cause of the block to be a chronic arachnoiditis. This was also verified at operation.

SUMMARY—The roentgenological demonstrations of air (5 to 8 cubic centimetres) injected into the lumbar space is a simple means of demonstrating the site of a complete subarachnoid block. In instances of chronic arachnoiditis, however, the air is too widely distributed and finely divided to be demonstrated roentgenologically.

The advantage of a lumbar air injection over lipiodol injected into the cervical subarachnoid space is its rapid absorption and the ease and lack of risk of the procedure.

TREATMENT OF TUBERCULOUS EMPYEMA COMPLICATED BY PYOGENIC INFECTION*

BY ADRIAN V S LAMBERT, M D
OF NEW YORK, N Y

TUBERCULAR infection of the pleura has been universally recognized as one of the causes of chronicity in empyema. It never was an unusual or rare condition. It has become much more common since the introduction and extensive use of artificial pneumothorax in the treatment of pulmonary tuberculosis.

The procedures designed for the treatment of chronic pyogenic infections of the pleura, such as the Schede, Estlander and Delorme operations, are not as a rule followed by successful results. On this account tubercular empyemata have been considered incurable. At the present time, however, with the advances in thoracic surgery, these cases may be successfully treated by new procedures especially designed for their care.

The appearance of tuberculous pus during the use of artificial pneumothorax, although disturbing, is not necessarily alarming, because patients will often tolerate large amounts well without presenting any untoward symptoms. The management of such cases will not be taken up at this time but our attention will be directed only to those cases of tuberculous empyema which are accompanied by pyogenic infections.

Such cases present a complicated problem, as there exist two distinct pathological processes demanding our attention. The proper treatment of the one, pyogenic infection, may be contrary to the most desirable procedure for the care of the other, namely, the tuberculous infection. Often the tubercular nature of the case is not recognized or even suspected until an appreciable time after drainage has been established by means of a rib resection.

A knowledge of the changes, which occur in tuberculosis of the pleura, is essential to a proper understanding of its treatment. The pleura may become affected by tuberculosis in two ways: through a blood-stream infection or through absorption of a pleural exudate containing tubercle bacilli. In a blood-stream infection the bacilli may lodge in any portion of the pleura either internal to or external to its elastic layer. After this lodgment true tubercles develop, and the process may progress through the various classical stages of a tubercular process elsewhere in the body including caseation.

The more frequent manner of involvement, however, is through absorption of bacilli from a pleural exudate. In this instance bacilli come from a focus within the lung. Under these circumstances a tubercular pleuritis develops, characterized by the formation of tubercular granulation tissue without the

* Read before the New York Surgical Society, March 14, 1934.

development of true tubercles and limited to that portion of the pleura lying internal to the elastic layer, the tubercular process rarely extending external to this layer. Usually this process is accompanied by a profuse pleural exudate of either clear or bloody serum. Should pyogenic organisms gain access to such an exudate the case will present all the appearances of an acute pyogenic empyema, and its tubercular nature will be completely masked. If, however, this primary serous exudate should be aspirated, the two layers of the pleura may become adherent, the pleural cavity become obliterated, and the process remain dormant for years, or, the case may run the course of a pulmonary tubercular lesion. Likewise after aspiration the exudate may reaccumulate, alter its character and gradually become more and more purulent, until a true tuberculous empyema is established.

Coincident with this alteration in the character of the exudate the parietal pleura undergoes profound pathological changes. The visceral pleura, on the other hand, never alters to the same degree. These changes in the parietal pleura are characterized by the development of tubercles internal to the elastic layer and the formation of non-tubercular fibrous tissue external to the elastic layer. This fibrous tissue may accumulate to a thickness of one or more centimetres. In cases of long duration it is not unusual to have calcareous plaques form throughout the pleura. These are usually limited to the inner, surface but rarely may involve the entire thickness of the pleura.

The pyogenic organisms may gain access to the pleural cavity in these cases in several different ways. Theoretically, they may enter via the blood- or lymph-stream, although we have no cases in which we have been convinced that this was their mode of entrance. They may be introduced from without through some fault in technic during aspiration. They may arise from the rupture of a small or large tuberculous focus in the lung. The seriousness of infection by this latter path will vary considerably depending on whether a patent pleuropulmonary fistula is or is not established. The presence of a patent pleuropulmonary fistula may alter materially the management of a case.

The organisms which we have recovered from such cases have been various strains of streptococci, staphylococci, pneumococci, the colon bacillus and numerous forms of anaerobes. Some of the latter have developed a foul odor, others have not.

The management of a tuberculous empyema with an infection of pyogenic organisms will be influenced by the severity of the patient's reaction to this pyogenic infection, and our treatment must be directed primarily toward its cure.

There have been a few cases which present symptoms of such profound sepsis, that an immediate drainage by rib resection must be done. A portion of the tenth rib in the scapular or posterior axillary line should be removed. This is a rib or two lower than is usually chosen in operations for an uncomplicated empyema, the tenth rib being selected so that with the subsequent rise of the diaphragm a tract leading into the pleural cavity will be established between the diaphragm and the chest-wall. Such a tract will heal more readily

than those extending directly through an intercostal space. When the sepsis has been controlled we proceed to obliterate the pleural space in a manner to be described later.

Most cases, although thoroughly septic, have not demanded immediate drainage by rib resection, and we attempt to eliminate the pyogenic organisms by irrigation with antiseptic solutions. We have employed various substances for this purpose, none of which has proved consistently satisfactory. A 1 per cent watery solution of gentian violet or crystalline violet, a purer form of the same substance, has given the best results. Doctor Amberson and Doctor Riggins have perfected the technic and will at some future date publish in detail their results. At this time it may be stated that the pyogenic organisms have been eliminated in a certain proportion of cases and in other cases the violent nature of the infection has been controlled sufficiently to allow us to proceed with the obliteration of the pleural space. The anaerobic organisms are more resistant to this form of treatment than are the ordinary pyogenic ones, and in the presence of a persistent pleuropulmonary fistula it has not been possible to render the exudate sterile. This is no doubt due to the constant reinfection from the focus within the lung.

The procedure in these cases is to aspirate the pleural exudate and replace it by an equal amount of air. A pyopneumothorax is thus established if one did not previously exist. Ten cc of a 1 per cent watery solution of gentian violet is left in the pleural cavity. Following this injection the exudate becomes a thick jelly which must be removed by irrigation with normal saline solution on subsequent days, and fresh gentian violet solution injected and left in the pleural cavity.

If it is not possible to control the septic manifestations promptly, a catheter is introduced through the tenth interspace by means of a trochar and cannula, and the accumulation of exudate prevented through drainage.

After the pyogenic infection has been controlled, an extrapleural thoracoplasty is done in order to obliterate the pleural cavity. The state of nutrition of the patient and any accompanying lesions which might serve as contraindications must be considered. Experience and judgment alone can determine the optimum time for operation.

The operation of extrapleural thoracoplasty is not a technically difficult one, and every well-trained surgeon should be able to perform it.

There are, however, certain features which are important and must be carried out to insure success. The procedure must be performed in several stages, and a few ribs only should be removed at any one time.

We employ a hockey stick or right-angled incision, the vertical limb extending 2 cc from the vertebral spines and the horizontal limb coming off at almost right angle extending forward to the mid-axillary line. We always remove the uppermost ribs at the first stage. The ribs are removed at their articulations with the tip of the transverse processes. In those cases in which the lung is completely collapsed against the mediastinum the transverse processes are removed and also the rib as far posteriorly as its neck.

TUBERCULOUS EMPYEMA COMPLICATED BY INFECTION

The removal of the transverse processes aids greatly in the obliteration of that portion of the pleural cavity lying in the vertebral gutter along the sides of the vertebral bodies. This is the space where residual sinuses are apt to occur.

The first rib must be removed anteriorly beyond the subclavian groove and if possible it is well to divide it beyond the attachment of the scalenus anticus muscle. This allows the obliteration of the extreme dome of the pleural cavity. It is important to remove the second and third ribs up to their attachments to the costal cartilages. These two ribs are the ones which hold out the upper portion of the pleural space and anything short of their complete removal will not serve the purpose. The full effect of the sinking in of the scapula is not obtained until a portion of the sixth rib has been removed, because the lower angle of the scapula rides on this rib and is held out by it. The fourth, fifth and sixth ribs are divided at the anterior axillary line or anterior to it, depending on whether the lung is partially or completely collapsed, and whether the right or left side is involved. As a rule more extensive portions of these ribs are removed on the right than on the left side. The remaining ribs are removed at their point of attachment to the diaphragm.

The success of this procedure depends on two important factors, both of which make this distinctly advantageous to the operations which attempt obliteration of the pleural cavity by removing the pleura and intercostal muscles first, two layers of tuberculous pleura when brought in contact with one another adhere even in the presence of pyogenic organisms provided the exudate is not allowed to accumulate. This must be prevented by adequate drainage and the removal of any air either by frequent aspiration or the introduction of a catheter. Second, the operative wounds heal by primary union because the procedure is undertaken in normal healthy tissue.

The foregoing procedure may be modified in cases having particularly extensive cavities or extremely thick or calcareous pleura. In these the sixth rib and transverse process are removed subperiosteally and then the fifth, fourth, third and second ribs are denuded of periosteum but left *in situ*. A portion of the first rib is then removed. The space between the denuded ribs on one side and the intercostal muscles and periosteum on the other is then firmly packed with gauze, pressing the parietal pleura, the intercostal muscles and the periosteum over toward the mediastinum. The skin and muscular flap is then sutured in place. After ten days the wound is reopened, the ribs removed and the gauze pack is taken out. This leaves two raw surfaces covered by fresh granulations. The wound is then closed without drainage. The advantage of this procedure is an immediate obliteration of the pleural space following the first step. A calcareous or very thick pleura is mechanically forced into a position where the two pleural surfaces are held in contact and the possibilities of failure due to a residual cavity are diminished.

In the cases in which open drainage has been established there will always remain a sinus or comparatively small cavity on the diaphragm. This may be closed in several ways. Paralysis of the diaphragm following division of the

phrenic will at times aid in obliterating these cavities situated on the diaphragm. We reserve the division of the phrenic until after the completion of the thoracoplasty believing that contraction of the diaphragm is an aid in drawing the anterior ends of the divided seventh to tenth ribs inward and that it is a disadvantage to have the abdominal viscera push upward toward the thorax and hold these rib ends outward. This is especially true on the right side where the liver serves as a compact solid organ.

The frequent and repeated cauterization of persistent pleural sinuses with 95 per cent carbolic acid will often close them. One must be meticulous, however, to cauterize the extreme depths of the sinus, otherwise the superficial portion will heal and a residual abscess reform. In a few instances where the cavity has been small or where a narrow tract has persisted we have laid these open and treated them as open granulating wounds.

SKELETAL MUSCLE SARCOMA

BY EDGAR M. BICK, M.D.

OF NEW YORK, N. Y.

FROM THE HOSPITAL FOR JOINT DISEASES AND FROM MT. SINAI HOSPITAL

TUMORS involving the skeletal muscles, while not of frequent occurrence, are by no means rare. Of these the two most common types are hæmangiomas and sarcomata. The former have been most adequately studied, and have been reported in large numbers.^{6 11 16} Hence they have been considered the more common. It has been the author's experience that the sarcomata are of equal if not greater frequency. Since 1913, when Kuttner and Landois¹³ reported 130 cases of skeletal muscle sarcomata culled from the literature, and added sixteen of their own, there has been no large series described. In reviewing the case records of recent years at the Hospital for Joint Diseases and Mt. Sinai Hospital, we were able to collect thirty-five instances of skeletal muscle tumor. Table I shows their histogenetic distribution.

TABLE I

Hæmangioma		11
Sarcoma		
Fibrosarcoma	13	
Neurofibrosarcoma	4	
Myxosarcoma	1	
Myosarcoma	1	
Chondrosarcoma	1	
	—	20
Fibroma		1
Neurofibroma (excluding von Recklinghausen's multiple neurofibromatosis)		2
Carcinoma		1
		—
Total		35

Of thirty-five tumors involving the skeletal muscles, twenty, or 57 per cent, were sarcomata, and eleven, or 31 per cent, were hæmangiomas. Of the sarcomata, the greater number, by far, were classified as fibrosarcomata. In Ewing,⁷ the same observation is made, without statistics, regarding the preponderance of fibrosarcomata among skeletal muscle sarcomata. The differentiation of neurofibrosarcoma from fibrosarcoma is difficult, and in some cases impossible. The former is apt to be encapsulated or, at least, well circumscribed, the latter more likely to be diffuse or less well demarcated. In our series neurofibrosarcomata were second in frequency (four cases). In addition to the sarcomata classified in Table I, two other types have been reported. Osteogenic sarcoma occasionally invades the adjacent muscle, especially at sites where muscle origin or insertion is directly in contact with

TABLE II
Muscle Sarcomata—20 Cases

Classification	Muscle	Age	Sex	Duration	Symptoms	Therapy	Remarks
1 Fibrosarcoma	Hamstring m group	60	F	5 mos	Soft tumor non mobile grape fruit size Painful only during last few weeks	Excised	Tumor was recurrent growth, X-ray treatment had been advised after first operation but was refused
2 Fibrosarcoma	Rectus abdominis m	27	F		Sausage shaped tumor 10 x 5 cms firm mobile No pain or tenderness	Excised with resection of muscle	Desmoid type of tumor, histological study proved it to be sarcomatous
3 Fibrosarcoma	Internal oblique m	27	F	1 yr	Orange-sized firm tumor appearing one month after an attack of acute right lower quadrant pain No pain or tenderness after appearance of tumor	Excised with resection of muscle	This tumor although a desmoid grew rapidly
4 Fibrosarcoma	Flexor muscles of forearm	42	M		Slowly growing tumor no pain or tenderness at any time	Excised	
5 Fibrosarcoma	Extensor communis digitorum m	13	F	2½ yrs	Slowly growing tumor, firm, no pain or tenderness at any time	Excised	Apparently originating from visceral aspect of muscle sheath involving muscle tissue directly without perforating the sheath
6 Fibrosarcoma	Hamstring m group	31	F		Large tumor surrounding thigh Painful, firm	No treatment	This was a third recurrence following two surgical excisions
7 Fibrosarcoma	Biceps femoris m	60	F	5 mos	Orange sized, firm tumor, painless until 3 wks before admission, then felt a dull ache	Excised	
8 Fibrosarcoma	Triceps brachialis m	24	F	2 mos	Slowly growing tumor No pain or tenderness at any time	Excised	
9 Fibrosarcoma	Rectus abdominis m	22	F	3 mos	Firm tumor sausage shaped No pain or tenderness at any time	Excised	

SKELETAL MUSCLE SARCOMA

10 Fibrosarcoma	Trapezius m	35	F	1 yr	Pain in occiput and upper spine 3 mos At end of this time a firm, slowly growing tumor appeared in trape- zius area No further pain until one month before admission Then lancin- ating pain radiating up occiput and down arm	Excised	Note presence of distinct radiation of pain along trunk distribution May have been an intramuscular neurofibrosarcoma
11 Fibrosarcoma	Rectus abdominis m	31	F		Lemon-sized tumor No pain or tender- ness at any time	Excised	
12 Fibrosarcoma	Semitendinosus and semi- membranosus mm	10	F	6 wks	Firm tumor No pain or tenderness at any time	Excised	Encapsulated, fixed to visceral layer of muscle sheaths
13 Fibrosarcoma	Rectus abdominis m	28	F	7 mos	Firm tumor No pain or tenderness at any time	Excised	Tumor first noted during abdominal enlargement of pregnancy
14 Neurofibrosarcoma	Flexor muscles of forearm	26	M	9 yrs	Firm mobile tumor Moderate pain	Excised	This was a second operation for re- currence
15 Neurofibrosarcoma	Extensor muscles of fore- arm	29	M	9 yrs	Walnut-sized tumor, firm, mobile Tender Pain for 5 days before ad- mission radiating down ulnar nerve	Excised	This was a second operation for re- currence
16 Neurofibrosarcoma	Peroneus longus m	26	M	Since childhood	Walnut-sized tumor, progressive growth following trauma about 1 yr before admission Tender Pain persisted following trauma	Excised	Tumor was encapsulated
17 Neurofibrosarcoma	Gastrocnemius m	42	F	7 yrs	Tumor present 7 yrs, no change in size since first noted, until several months before admission began to grow rapidly No known trauma Tumor pulsation on palpation	Excised	Tumor was encapsulated
18 Myosarcoma	Flexor muscle group of forearm	52	F	3 yrs	Soft tumor, tender, painful	Excised	
19 Fibrochondrosarcoma	Palmaris brevis m	23	F		Tumor present on hypothenar emi- nence Painful No known trauma		
20 Myosarcoma (prob- ably Fibrosarcoma)	Vastus lateralis			3 mos	Grapefruit-sized tumor, growth, pain- ful when walking Invaded sur- rounding structures	Excised	Although classified originally as myo- sarcoma this tumor had clinical characteristics of a fibrosarcoma Slides not now available

bone, that is, at points of osteoperiosteum-muscle conjunction. However, osteogenic sarcomata may at times invade adjacent muscle by perforating both periosteum and muscle sheath^{12 9}. Rhabdomyosarcomata have been reported by Cohen,⁵ Wolbach,²⁰ and Muller¹⁷. The diagnosis of rhabdomyoma or its complexes has been doubted by several pathologists^{7 10 13}. Its true nature brings up a problem in histogenesis extraneous to the present purpose. Briefly, the term muscle tumor designates a neoplasm involving the muscle body. It must not necessarily be composed of muscle fibres, in fact, it rarely, if ever, is. In certain sarcomata of skeletal muscle, the muscle cells play a secondary part, in others they are concerned only spacially. In the presence of a rapidly growing sarcoma the muscle cells may form part of the stroma due to the infiltrative type of growth characteristic of these tumors¹⁴. Whether a so-called rhabdomyosarcoma is a true derivative of muscle cells, or a sarcoma or teratoma in which such cells are fortuitously included, is the crux of this problem.

Sarcoma may involve the skeletal muscle in several ways. First, the tissue of origin may be intramuscular, that is, sarcolemma, perimysium, interfascicular connective tissue, the visceral layer of muscle sheath, perineural or perivascular connective-tissue sheaths. Secondly, the tumor may infiltrate the muscle body from a source outside, but in direct contact with it, such as, for example, a fibrosarcoma of periosteal or intermuscular fascial origin. This infiltration by direct contact is also the source of intramuscular osteo- and chondrosarcomata. Thirdly, the muscle body may be involved by a metastatic process as occurs when a large secondary fibrosarcoma appears in the muscles and surrounding soft tissues of the thigh following the removal of a supposedly benign fibroma from the plantar surface of the foot⁴.

Age—The statement is repeatedly made that sarcoma occurs most commonly in youth or the young adult. However, fibrosarcoma of the extremities may occur at any age and, in fact, was found to be most frequent in the fourth and fifth decades³. The ages of the twenty cases herein listed range from ten to sixty, appearing with maximum frequency between twenty and forty. The age groups for fibrosarcoma and neurofibrosarcoma were similar. This is in marked contrast to a characteristic age of origin for intramuscular hæmangiomas. The latter, in all probability, invariably a congenital lesion,^{6 11} is at least usually first noted in early childhood.

Duration—Of nine cases of fibrosarcomata in which the duration of tumor was noted, in all but one it was a year or less. In one case it was two and a half years. (Comparable figures not given by Kuttner and Landois.) In four cases of neurofibrosarcomata the duration was from seven to twenty-six years. The long duration of a static neurofibrosarcoma followed by a rather brief period of rapid growth, often, but not always after trauma, is characteristic of these tumors of nerve sheath derivation⁴. Likewise, it is not unusual for a fibrosarcoma of the anterior abdominal wall to be discovered only at the time of pregnancy when distention of the musculature brings a hitherto unnoticed sausage-shaped tumor into prominence.

Although a muscle tumor of relatively short duration suggests a diagnosis of fibrosarcoma, one of longer duration does not necessarily signify benignity. In the presence of a neoplasm which has existed from childhood, hæmangioma must be considered, in one of long duration having an onset later in life, a neurofibrosarcoma is a probable diagnosis.

Location—The sites of predilection for intramuscular sarcomata are the thigh, abdominal wall, and forearm, sixteen of the twenty cases occurring in these regions with approximately equal frequency. Two of the neurofibrosarcomata occurred in the leg and two in the forearm. Fibrosarcomata occurring in the abdominal musculature have long been known under an old clinical name, "desmoid," i.e., fibrous tumor. These usually involve the rectus abdominis of either side.

Pain—Pain is rarely an early symptom. In most instances, although a minor ache may have been present at recurring intervals, actual pain is either never experienced, or appears only when the tumor is well advanced in size. When present, it is apt to be described as "rheumatic." Unlike bone sarcoma the pain is seldom constant. The presence of pain radiating down a specified nerve distribution is suggestive of, but not pathognomonic for a neurogenic tumor or neurofibrosarcoma.^{3 4} Any muscle tumor which in its growth involves a nerve spacially will produce similar radiating pain. Muscle sarcomata may or may not be tender. Usually they are not. However, occasionally one finds some moderate pain present for a while after a slight trauma.

The absence or inconsequentiality of pain in these tumors explains the rarity of early diagnosis. Situated as they are in deep resilient structures, covered by soft subcutaneous fat, the tumor of itself draws no attention until its presence is visibly perceptible. This occurs only after it has attained a considerable size. Occasionally, however, palpation during the course of a careful examination may discover it before a visible tumor appears, but, even so, it must have reached a fairly large size before becoming palpable through the overlying tissues.

Mobility—Primary muscle tumors in general have a characteristic mobility, especially when felt at a stage in their growth before adjacent tissues are involved. They are deep-seated, the skin and superficial tissues are mobile in reference to the tumor, the tumor is mobile in reference to underlying bone, and it can be felt to change position during contraction or elongation of the muscle. The amplitude of change in position during muscle activity diminishes as its situation approaches the functional mid-point of the muscle, and increases as it is distant from that point. Until the size of the intramuscular tumor is such that it mechanically interferes with the excursion of the muscle, or until in its growth it perforates the muscle sheath and attaches to adjacent fixed tissues, there is no perceptible disturbance in muscle function. This, of course, does not apply to muscle tumors of the second category (v s), where the muscle has been involved by infiltration.

from adjacent tissues In these latter cases mobility is either entirely restricted or is palpable as a mass waving on its pedicle

Size—In size, skeletal muscle sarcomata when first seen range from that of a pigeon's egg to a large grapefruit The latter are not infrequently encountered in the thigh When occurring in the abdominal wall they usually resemble a large frankfurter sausage in size and shape

Consistency—These tumors are characteristically firm, occasionally to the point of simulating bony hardness A soft muscle tumor suggests but cannot define a hæmangioma, since a myxosarcoma may be quite limp to the touch

Gross pathology—A knowledge of the growth characteristics of sarcomata is essential to a proper conception of therapeutic approach These neoplasms grow not by invasion, as does carcinoma with its gross displacement of the recipient tissue, but rather by infiltration, an insidious penetration of the connective-tissue framework of the area involved Hence a definite line of demarcation never becomes apparent A gross mass may be seen where the sarcomatous tissue is dense, but the borders of this mass will be fringed with long strands of neoplastic fibrils extending into the adjacent connective-tissue pathways It is only in the neurofibrosarcomata that encapsulation is sometimes found In these tumors there seems to be some factor (a problem, incidentally, as yet unsolved) which confines the local growth, though not the metastatic, to connective tissue of nerve-sheath origin

The malignancy of sarcoma varies as does that of carcinoma Experience teaches, for example, that the desmoid of the anterior abdominal wall is almost always of low malignancy When metastasis occurs in sarcoma it takes place directly through the blood-vessels rather than through the lymphatics⁷ Hence, enlargement of the proximal lymph-nodes does not occur in sarcomata of the extremities as it invariably does in carcinoma⁸ In sarcoma, metastasis is apt to appear first in the lungs, arriving through the blood-stream without intermediate rest points Thus the potential danger to life is considerable even in the early stages of muscle sarcoma

Biopsy—The value of biopsy in skeletal muscle sarcoma is the same as that for other sarcoma The inherent sources of error must be weighed against the invaluable advantages of a true diagnosis when it is obtained This problem is also extraneous to the present study However, it may be here stated that the purpose of this series of studies by the present author, as of similar studies by other surgeons, is to so define and describe the clinical aspect of many tumors as to make diagnosis possible, or, at least, reasonably certain, on the basis of clinical history and examination In this way, the X-ray and biopsy will assume their proper functions as methods of laboratory confirmation in well-indicated cases

Therapy—The treatment of primary intramuscular fibrosarcoma or myxosarcoma is excision of the tumor with the surrounding muscle tissue as extensively as is feasible, if necessary, even to the resection of the entire

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muscle Close scrutiny must be maintained for evidence of involvement of nearby fascial layers Following this there should be given a prolonged course of deep radiation This is advocated with full appreciation for the fact that tumors of connective-tissue origin stand well down in the series of radiosensitivity However, the danger to life is such that any additional factor of safety beyond surgical excision should be added to the treatment Radiation properly applied over a sufficiently prolonged period of time may in some instances be a life-saving device In the presence of the secondary type of muscle sarcoma, the excision must of course include a wider area In such cases involving the muscles of extremities, amputation is the treatment of choice

Neurofibrosarcomata are among the most radioresistant of all sarcomata It is doubtful whether radiation ever affects them On the other hand, the complete excision of intramuscular neurofibrosarcomata is often possible due to the presence of a well-encapsulated mass (v s) It is our opinion that, with present knowledge, nothing can be done in these cases to avoid metastasis other than amputation The success of therapy in skeletal muscle sarcomata depends upon (1) the grade of malignancy of the tumor at the time of treatment, (2) early recognition and differentiation, and (3) the completeness of excision These factors are given according to their degrees of importance Radiation, while always to be advocated, is still of doubtful efficacy in determining the outcome of any given case

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LOCALIZED CHRONIC ULCERATIVE ILEITIS

BY ARTHUR D BISSELL, M D

OF CHICAGO, ILL

FROM THE DEPARTMENT OF SURGERY OF THE UNIVERSITY OF CHICAGO

FOR the last twenty-five years and during the last decade particularly, there have been sporadic reports in the literature of cases loosely classified under the heading granulomata of the intestine

Until 1909, when Heinrich Braun referred to a case previously reported by him and collected reports on several other cases, the condition was practically disregarded in both Europe and America. Probably many cases of intestinal granulomata had been seen prior to this time, in fact some had been reported. But the majority of such cases were relegated to a pathological discard under such headings as tuberculomata, malignancies and the granulomata of syphilis, and their true nature never questioned or studied.

In 1909, Braun, pointing out the importance and difficulty of differentiating these intestinal granulomata from neoplasms of the intestine, collected six cases (including two of his own) of this type. The granulomata were situated at various places in the large intestine and the majority caused obstructive symptoms. In most cases a mass could be felt. In none of the cases was the etiology apparent. In 1920, Tietze⁶ reviewed all literature on this type of case and added to it several cases of his own. Moschcowitz and Wilensky,⁵ in 1923, reported four cases, in one of which the terminal ileum was involved. In 1925, Coffen⁴ added a case to the literature and cited previous cases as reported by Braun, Moschcowitz and Wilensky. In 1931, Mock³ described ten cases of granulomata and, in 1932, Golob² reported another case, discussed the subject further, and made some suggestions as to its etiology.

The etiology of the condition is exceedingly obscure. Many cases of granulomata are found apparently arising around a foreign body. Mock believes that they are usually due to a low-grade infection. Golob cited a case in which he believed the presence of a duodenal ulcer with its "constantly irritating influence over the ileocæcal region" might have been a predisposing factor.

Until 1932 no attempt had been made to differentiate a specific entity from the types of cases which had previously been reported. They were simply called intestinal granulomata, and they were found throughout the large intestine, in the omentum and occasionally involving the terminal ileum and proximal cæcum. In 1932 Crohn and his co-workers¹ isolated from this mass of heterogeneous granulomata a specific entity which they called "regional ileitis." In a review of the work by Tietze and Mock they were unable to find a report of a case which approached the picture which they had discussed. In one case reported by Moschcowitz and Wilensky, however,

there was a close resemblance to the type of case they classified as regional ileitis

Regional ileitis, as described by Crohn *et al*, is a disease which clinically suggests ulcerative colitis. It is characterized by fever, diarrhoea, and emaciation and eventually leads to intestinal obstruction requiring surgical interference. In all cases a mass is present in the lower right iliac fossa. In all cases the terminal ileum is alone involved. The process begins at the ileocaecal valve and extends upward, involving the ileum usually for a distance of from 20 to 30 centimetres. Often there are fistulae leading to adjacent segments of the colon and occasionally to the anterior abdominal wall. The etiology of the condition is unknown.

Characteristically, the pathology is as follows. The inflammatory process begins at the ileocaecal valve and usually involves 20 to 25 centimetres of the distal ileum. It is most pronounced at the valve, the process becoming less severe and gradually shading off into normal intestine, proximally. The submucosal, and to a less extent the muscular, layers of the bowel show hyperplastic and inflammatory changes. The walls are thickened, the lumen made smaller. The adjacent mesentery is greatly thickened and fibrotic.

The formation of fistulous tracts into adjacent loops of bowel (sigmoid, caecum, colon) is common. These fistulae are preceded by slow perforations giving rise to walled-off abscesses which, if drained, result in intractable faecal fistulae.

Microscopically the picture is one of non-specific inflammation and proliferation. In many cases the mucous membrane is destroyed and often replaced by an atrophic layer of epithelium. Giant cells are occasionally seen. They are interpreted by Crohn to be due to a foreign-body reaction to minute particles of vegetable material entrapped in lymphatics during the process of healing.

In half of the cases reported by Crohn, previous appendectomy had been done. It is pointed out that in cases in which no appendectomy had been done, the walls of the appendix showed inflammatory change but the mucosa was normal.

The disease is limited to young adults. Males are more often affected. The disease lasts over months or years. Diarrhoea, fever, loss of weight and anaemia are almost constant features. The temperature is usually intermittent with periods of remission. It rarely goes higher than 103° F. The diarrhoea is the chief complaint. Two to four stools a day of varying consistency, but always containing mucus and often blood and pus, are usually the case. Tenesmus is always lacking.

The authors state that perirectal abscesses, condylomata and peri-anal fissures are never found since the colon and rectum are not involved.

Vomiting, accompanied by pain and visible peristalsis, is present in the stenotic cases. The pain is dull and cramp-like, and may be fairly general in the lower abdomen or localized in the right lower quadrant. Occult blood is found in the stools. The white count is usually normal but may be slightly elevated.

The authors list characteristic findings in the physical examination as follows:

(1) A mass in the right lower quadrant. (2) Evidence of fistula formation. (3) Emaciation and anaemia. (4) Evidences of previous appendectomy. (5) Evidences of intestinal obstruction.

The disease may be divided into four types, according to Crohn. In one type the disease simulates acute appendicitis. There are signs of acute intra-abdominal inflammation with an elevation of temperature and leucocyte count, tenderness in the lower right quadrant and occasionally a mass in this area. If operation is done at this time, the terminal ileum is greatly thickened, red, blotchy and surrounded by oedematous tissues. Peri-appendicitis is present, and occasionally one finds an abscess. In another type symptoms of ulcerative enteritis with colicky abdominal pains, diarrhoea, and elevated

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temperature predominate Loss of weight, anæmia, and general weakness are characteristic of the later phases of this type Clinically it passes slowly into the stenotic type of the disease In the stenotic type, which is the most common, the symptoms are those of small bowel obstruction of varying degree Cramps, borborygmus, occasional vomiting, and constipation may be present In the last type the outstanding feature is the presence of persistent fæcal fistulæ These fistulæ follow an attempt to drain what are thought to be appendiceal abscesses Fistulæ, it is pointed out, may develop after the original drainage wound has been healed for several months

In the roentgenographical examination two observations are of value in the diagnosis Because of the clinical resemblance of this disease to ulcerative colitis, a barium enema is usually first given This examination is negative because the disease stops at the ileocæcal valve A barium meal, however, usually denotes a fluid level in the terminal ileum and delayed motivity in this region In the stenotic type the delay is pronounced

Regional ileitis is to be differentiated from ulcerative colitis, ileocæcal tuberculosis, fibroplastic appendicitis, carcinoma of the terminal ileum, Hodgkin's disease, actinomycosis, sarcoma, intestinal or mesenteric tuberculosis and non-specific proctitis

The treatment of the condition is primarily surgical Medical treatment is palliative and supportive Resection of the diseased segment leads to a cure of the condition in all patients surviving the operation

CASE REPORT—A man aged thirty-nine was admitted to the Billings Hospital September 19, 1932, on the service of Doctor Palmer complaining of diarrhœa of four years' standing, intermittent abdominal cramps, loss of 49 pounds in four years Until five years ago he had been entirely well He then developed a diarrhœa and had as many as fifteen or sixteen thin, watery stools daily He averaged from six to eight stools daily This diarrhœa persisted intermittently, with occasional remissions lasting from several days to a month, until his entrance to the hospital Occasionally there was tenesmus associated with this diarrhœa, and though there was mucus in nearly all the stools, no blood or pus was ever seen During the remissions, the stools were usually of a normal consistency, however, there were always at least two movements daily The diarrhœa occurred without relation to the type of food eaten or to the activity of the patient Associated with this diarrhœa, were abdominal cramps which were partially relieved by defecation and enemata, and an almost constant, dull, aching pain in the lower abdomen, which frequently radiated to the right loin

The patient's family physician sent him to a nearby hospital for observation While there gastro-intestinal X-rays were taken, gastric analysis made and stools examined After three days the patient was discharged, told that there was nothing organically wrong with him, and put on a low-residue diet of milk, cereals, *etc* He adhered to this diet for six weeks with no relief

In about August of 1928 he went to a clinic where, after eight days of observation, he was told that he had a fissure in ano He was advised to rest in the country, eat a normal diet and take retention enemata of warm olive-oil twice daily This advice was followed, the patient remaining in the country for one month At the end of this time he had experienced no relief He sought the advice of another doctor in Chicago and remained under his care for three months During this time the treatment was purely dietary with the exception of enemata given night and morning After three months of this treatment, during which the patient felt somewhat relieved, he developed an ischiorectal abscess This was opened and the physician stated that it was due to a fistula and that it would heal spontaneously The drainage persisted for three months and finally the patient went for treatment to a sanitarium which specialized in rectal disease During all this time the diarrhœa and abdominal pains persisted intermittently After eight operations the patient was discharged as cured so far as the fistula was concerned He went home for about two months When he left the hospital he felt much better and was having only occasional cramps and diarrhœa About two months

later, however, the diarrhoea and pains grew worse and he again went to a clinic for examination and treatment

Before entering the clinic he noticed that he felt feverish. During his five weeks' stay he ran a temperature of from 98.6° to 103° F. The fever persisted until about ten days before his dismissal. While in the clinic the patient developed frequency (about every thirty minutes), burning, and nocturia. He was cystoscoped and told that his urinary symptoms were due to mechanical causes. The urinary difficulties lasted until about three weeks after his dismissal from the hospital.

The patient was told on entering the clinic that a mass could be felt in his rectum and that it could be seen in X-ray examination. Colonic irrigations were instigated and diathermy treatments given. The patient states that as a result of this treatment he felt much better. The diarrhoea and pain disappeared and he gained in weight. He was discharged from the hospital and told to continue the diathermy and irrigations. This he did until January, 1932. After leaving the clinic the diarrhoea and abdominal pain recurred but were neither so severe nor so frequent as before. The patient discontinued the diathermy. After a brief period, pain and diarrhoea became more severe. He again tried diathermy, this time with no relief. He entered this hospital in August, 1932, for observation and treatment.

His past history, with the exception of that which has already been given, was largely irrelevant. His best weight five years ago was 210 pounds. One year before entering the hospital he weighed 143 pounds. He had lost 20 pounds in the last six weeks.

It was brought out in the history that his attacks of pain were much worse at night and that a bowel movement only partially relieved them. Associated with the abdominal pain there was a right lumbar pain, which, though less severe than the cramps, lasted long after they had ceased. In addition to the complaints of diarrhoea, pain, and progressive weakness and loss of weight, the patient stated that for several months he had had frequency of six to eight times a day, nocturia of two times, and dribbling and incontinence which had been growing progressively worse for the last six weeks.

He was a fairly well-developed, fairly well-nourished white male who looked at least five years older than his stated age, and who was not acutely ill. The physical examination was essentially negative except for the following findings.

Heart—There was a soft systolic murmur over the aortic area which was transmitted up the neck. The heart was otherwise normal.

Abdomen—The abdominal musculature was well developed and somewhat spastic. There was some generalized tenderness all over the lower abdomen. The entire abdomen was tympanic. No fluid was found on percussion nor were there any areas of definite dullness. The bowel was distended and vigorous peristalsis was seen to occur at five-minute intervals.

During a typical attack of pain the spasticity of the muscles of the lower right quadrant increased enormously and a definite swelling could be seen in this area. At the same time visible peristalsis occurred and then, accompanied by much rumbling and gurgling, the mass diminished in size and, together with the spasticity of the overlying musculature, disappeared.

Rectal examination revealed the scars of previous operations. At the upper edge of the prostate a large, irregular mass was felt which did not seem to involve the rectal wall. The mass was not ballotable.

Proctoscopic examination revealed a sudden narrowing of the lumen of the rectum at about 12 centimetres as if from pressure from without. The proctoscope could not be manipulated beyond this point.

Laboratory Findings—Blood hæmoglobin 92 per cent. Sahli, red blood cells 4,490,000, white blood cells 6,500, differential polymorphonuclears 57, large leucocytes 2, small leucocytes 34, mononuclears 4, eosinophiles 4, basophiles 0. Blood Wassermann and Kahn negative. Urine negative except for 5 to 10 white blood cells per high powered

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field on two out of six examinations. Stools negative for blood and mucus on all examinations.

The patient remained on the medical service for nine days after his entrance into the hospital. During this time a gastro-intestinal X-ray was made.

X-ray Report—Colon fluoroscopy August 22, 1932. With enema the colon fills easily and completely from the rectum to the tip of the cæcum and after vigorous manipulation through the abdominal wall the barium enters the ileum in a fine stream. The appendix is not seen.

Stomach fluoroscopy August 23, 1932. Barium given yesterday is scattered throughout colon. Oral barium is taken without difficulty. The œsophagus and stomach are entirely normal except that the latter is in high transverse position with a posterior bulb (Figs 1 and 2).



FIG 1

FIG 2

FIG 1—Barium enema five days before operation showing sharp retention of barium at ileocecal valve.

FIG 2—Barium meal four days before operation, twenty-three hours after ingestion. Note enormous dilation of terminal coils of ileum with typical stepladder arrangement. Stoppage of barium at a point near the ileocecal valve.

Serial No 3. Abdomen. Patient prone, six hours after the ingestion of the oral barium. The stomach is empty. The coils of small intestine contain most of the barium and appear enormously dilated. Small amounts are also seen in the colon.

Serial No 4. Twenty-three hours after ingestion of barium. There is still considerable retention of the barium within the small intestine. Barium is also seen in the cæcum, transverse and descending colon.

Serial No 5. Approximately forty-eight hours after ingestion of oral barium. The barium has now almost completely left the small intestine and is within the colon. Obviously there is delayed emptying time of the small intestine with marked dilation of it. We have not been able to demonstrate a mass within the gastro-intestinal tract though we can infer the presence of something within the abdomen causing a partial obstruction to the passage of the barium meal. The impression resulting was of a mass (?) within the abdomen causing delayed motility of barium through the small intestine.

While on the medical service the patient was given tincture of belladonna and

deodorized tincture of opium in an effort to relieve his symptoms. Further study of the case was interrupted about a week after the patient's entrance into the hospital by the rapid onset of alarming signs of acute intestinal obstruction which seemed to be located at the ileocaecal valve which had previously been shown to be strictured.

Operation August 27, 1932 Ethylene anaesthesia. Dr Andrews. Through a right-rectus incision an enormous mass of matted, indurated bowel was discovered in the cul-de-sac. This was freed by finger dissection and the pocket from which it was taken packed with gauze. The mass was then delivered outside the abdomen and found to be composed of terminal ileum. The appendix and caecum were grossly normal. The ileum, together with its mesentery, was enormously thickened for a distance of about 8 inches above the ileocaecal valve. The ileum above this mass was markedly hypertrophied due to the obstruction. Scattered throughout the mesentery were large, indurated glands, some of which fluctuated. Exploration of the abdominal cavity revealed no signs of tuberculosis. It was therefore decided that the intestinal pathology was due to a low-grade pyogenic infection in the terminal ileum.



FIG 3—Photograph of excised specimen. Note enormous thickness of walls of terminal ileum and normal appendix and caecum at bottom.

A Mikulicz exteriorization was made and a portion of the caecum, together with the indurated ileum, was brought outside the abdominal wall and sutured in place. The abdominal wall was then partially closed around the loop of exteriorized intestine.

The next day, under nitrous-oxide anaesthesia, the terminal portion of the ileum and proximal portion of the caecum were amputated with the actual cautery and a right-angle clamp applied to the spur. The walls of the ileum measured 3 to 4 centimetres in thickness and the lumen was about 1 centimetre in diameter. The wound was partially closed with interrupted silk sutures.

Pathological Report—Gross—The specimen is that of terminal ileum, appendix and proximal caecum. The ileum is enormously hypertrophied and indurated. The attached mesentery is markedly thickened, indurated and hyperaemic and contains many hyperplastic lymph-nodes which display a reddish-gray pulp on cut section. The walls of the appendix and caecum are slightly thickened.

On cut section, the walls of the ileum, particularly at its distal end, are seen to be enormously thickened and fibrotic (Fig 3), the lumen being encroached upon. Near the ileocaecal junction the walls measure 3 to 4 centimetres in thickness while the lumen

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is only 1 centimetre in diameter. The hyperplasia of the walls becomes gradually less marked proximally, and at about 25 centimetres from the ileocaecal junction the ileum is apparently normal. At various places near the ileocaecal junction, the mucosa is denuded and exhibits shallow serpiginous ulcers with low margins.

Microscopical—The walls of the ileum are markedly thickened and oedematous. The mucosa is lacking in some areas with the formation of shallow ulcers with overhanging edges. There is a marked diffuse and focal lymphocytic infiltration of the submucosal layers, the normal lymph follicles are hyperplastic and the vessels are engorged (Fig 4). The muscular layer is markedly hypertrophied and exhibits diffuse leucocytic infiltration. The serosa is covered by a thin layer of leucocytes and degenerating fibrin. No granulomas are present in any of the sections.



FIG 4—2 \times magnification of section through inflamed area, showing numerous ulcerations, hypertrophy and oedema of outer layers and marked focal collections of lymphocytes.

Sections from the appendix are essentially negative except for a thin layer of fibrino-purulent exudate over the serosa.

Following this operation the patient made a fairly rapid convalescence, his urinary symptoms entirely disappeared, and he regained his appetite and was relieved of all pain. The diarrhoea, however, persisted, probably due to the fact that all the irritated portion of the ileum had not been removed at the operation. The liquid ileostomy drainage was alkaline (Ph 8) and had a marked digestive action on the wound edges, which became excoriated and extremely tender. In an effort to neutralize this faecal drainage, continuous irrigation with 1/100 N hydrochloric acid was instigated. This was combined with continuous suction designed to carry away excess faecal material and irritating solution. The condition of the wound materially improved under this treatment. In addition to this persistent diarrhoea from the ileostomy there was marked infection

of the wound and considerable purulent drainage, possibly due to the breaking down of the mesenteric glands seen at operation

It was not considered safe to attempt a closure of the ileostomy in the face of such marked infection

On the twenty-fourth of October, about a month after the original operation, the patient, who had been up in a wheel chair for two days, suddenly developed all the signs of an acute intestinal obstruction with vomiting, distention, and marked visible persistalsis

On the following day under ethylene anæsthesia, laparotomy through the old operative wound was done and revealed a fibrous band constricting the ileum just proximal to the ileostomy opening This was divided, allowing material which had been dammed back in the ileum to well up in the field A catheter was sutured into the ileostomy opening and the gut closed around it The wound was then closed around the tube in layers

Drainage from the tube persisted for about six days The tube was then withdrawn and the wound strapped with adhesive tape Healing took place almost by first intention The patient was discharged November 20, 1932 At that time there was a very small amount of purulent drainage from the wound There had been no fecal drainage since the removal of the tube

Discussion—This case seems to us to belong in the category described by Crohn and called by him regional ileitis It belongs in the type which they designate as stenotic It differs from their cases in several respects None of their cases had had rectal fissures or fistulæ, as had our case Tenesmus was not one of the characteristic features of the cases they reported Furthermore, the formation of fistulæ from the affected gut to adjacent colon or sigmoid was an important finding in their cases which was not present in ours We feel that the differences between our case and the cases they described may be attributed to the fact that in our case the affected ileum was bound down in cul-de-sac Since the history of the disease dates back well before the appearance of the rectal abscess, it may be assumed that the ileitis preceded the abscess formation If this is true, it would seem entirely possible that the presence of this inflammation in the cul-de-sac could easily give rise to an abscess, which, if drained, would cause a persistent rectal fistula, which, as in their cases of abdominal fistulæ, was very difficult to cure because of the underlying inflammatory mass

Furthermore, the occasional tenesmus which our case had could also be attributed to the proximity of the ileitis to, and its consequent irritation of, the rectum

The urinary symptoms, so outstanding a feature of our case, were certainly due to pressure and irritation of the bladder by the mass in the cul-de-sac

Another feature of our case which was due to the position of the involved ileum is the fact that it might be easily confused with non-specific proctitis In this condition a brawny, indurated mass outside the rectal wall is one of the outstanding features

The absence of secondary anæmia in our case can possibly be explained by the remissions which our patient had had repeatedly during the course of the disease

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In all other respects the picture is certainly typical of the regional ileitis described by Crohn

NOTE—Since this report was written another case of localized chronic ulcerative ileitis has been seen and operated at this hospital. The patient, age twenty-eight, entered the hospital on June 9, 1933, complaining of a tender mass in the lower right quadrant which he had accidentally palpated five days before entrance to the hospital. Two and a half weeks before entrance he had noticed a dull ache which occasionally became a sharp pain in this same region. The pain was rhythmical in character, occurring at intervals of a half minute and lasting for from three to ten seconds. The patient was conscious of this pain for approximately two weeks following its first appearance. It continued during this period with about the same degree of severity. For four days before hospitalization the pain had become much less severe. At no time was there any associated nausea or vomiting, but on careful questioning the patient stated that for the past four years there was a tendency to diarrhoea in the morning. No blood had ever been seen in the stools.

On physical examination a mass about the size of a lemon could be palpated in the lower right quadrant. The mass was tender and freely moveable. Otherwise the physical examination was negative.

Fluoroscopy and X-ray plates revealed a definite filling defect at the ileocaecal junction which was not obstructive but was definitely tender to palpation.

On the basis of physical examination and X-ray findings a tentative diagnosis of neoplasm or granuloma of the caecum was made. Because of the tenderness demonstrable both at physical and fluoroscopic examination the latter diagnosis was thought to be the more probable.

On entrance to the hospital the white blood cells were 10,000, red blood cells 4,900,000, haemoglobin 85 per cent (Sahli), pulse 100, temperature 98.6, urine negative.

On June 10, 1933, a laparotomy was done by Doctor Phemister through a right rectus incision and a hard mass found at the ileocaecal junction. Several large, indurated lymph nodes in the adjoining mesentery could be palpated, in a line extending medially and upward. The terminal ten centimetres of ileum and proximal fifteen centimetres of caecum and ascending colon were resected and a side-to-side anastomosis made.

A frozen section at the time of operation was diagnosed as being suspicious of lymphosarcoma.

The patient made an uneventful recovery and was discharged two weeks following the operation.

The bowel resected at operation showed the following gross pathology. On opening into the lumen of the ileum the wall was found to be markedly thickened and a redundant portion of the mucosa extended for a distance of about one centimetre through the ileocaecal valve. A superficial longitudinal erosion of the mucosa of the ileum two and a half by one centimetre was found which ended sharply at the caecum. The appendix was abnormally long and curved on its mesentery in a semi-circle but was otherwise grossly negative. A mass of enlarged lymph glands was present on the posterior medial aspect of the ileocaecal junction. The largest of these nodes measured two and a half centimetres across and the smallest eight millimetres. On cross section these nodes appeared homogeneously grayish white. The caecum and colon were grossly normal.

Microscopically the picture is one of non-specific inflammation. The mucosal ulcer is shallow and has sharp margins. The mucosa adjacent to the ulcer and proximal to it for a distance of approximately ten centimetres is hyperaemic and infiltrated with polymorphonuclear neutrophils. A markedly hyperplastic Peyer's patch appears at one margin. The wall of the ileum beneath and beyond the ulcer is two to three times its normal thickness and exhibits fibrosis with a marked diffuse and focal infiltration.

consisting largely of round cells and polymorphonuclear neutrophiles in almost equal numbers. At a distance of six centimetres from the mucosal ulcer the serosa is moderately infiltrated in the same manner. This polymorphonuclear infiltration may also be seen at the tip of the appendix but does not extend through the muscularis or serosa. The cæcum and ascending colon are microscopically essentially normal. There is no evidence of tuberculosis or neoplasm in any of the sections examined.

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ANTERIOR HEMIPYLORECTOMY FOR ABERRANT PANCREATIC TISSUE OF THE DUODENUM—DIAGNOSTIC DIFFICULTIES

By R. RUSSELL BEST, M D, AND WARNER F. BOWERS, M D

OF OMAHA, NEBR

DEPARTMENT OF SURGERY OF THE UNIVERSITY OF NEBRASKA

Historical—Aberrant or accessory pancreas, although recognized for a long period of time and first reported by Klob in 1859, is still quite a rare condition which is usually unsuspected until found on the autopsy table or occasionally on the operating table. Aberrant nodules which have been removed at operation have rarely been considered the etiological factors in the conditions which have made operation necessary. This is shown in the cases of Farr¹⁰ and Cafritz.⁴ Farr operated for pre-pyloric ulcer and in addition found an unsuspected aberrant nodule on the jejunum. This was excised and the defect was used as the gastroenterostomy stoma. Cafritz reported a case resembling both cholecystitis and ulcer in which laparotomy was done with a diagnosis of chronic appendicitis and an aberrant nodule was found on the anterior surface of the duodenum. Thirty-two cases of annular pancreas have been reported and there are records of not more than sixty cases of aberrant nodules of pancreatic tissue. These figures include cases where aberrant pancreas was discovered at autopsy.

Embryology—In order to understand the origin of aberrant pancreas and to see why it is found only in certain situations, it is necessary to briefly outline the embryological development of the pancreas. There are originally three anlagen, the dorsal and the right and left ventral. The dorsal pancreas arises as a diverticulum from the dorsal wall of the foregut, slightly above the level of the common bile-duct, whereas the ventral diverticula grow down from the junction of the common bile-duct with the intestinal tube. The ventral anlagen fuse and grow to the right to meet the dorsal cell mass. If the left ventral lobe continues to grow on around the enteric tube, an annular pancreas is formed. Normally the three anlagen fuse to form one cell mass but later we shall see how aberrant nodules may develop.

Theories of Origin—The origin of accessory or aberrant pancreatic tissue has been variously explained by different investigators. Gliniski assumes a non-fusion of the three primary anlagen while Zenker postulates the presence of accessory anlagen. Thyng supports the views of Zenker and is able to demonstrate accessory pancreatic anlagen in two pig embryos. Bentler explains the condition as an atavistic phenomenon but evidence for this view is slight. Lubarsch assumes the presence of inflammatory adhesions, so that as growth proceeds, small masses of pancreatic cells are pulled away from the original cell mass. Horgan¹⁵ holds practically the same view except that he feels that the adhesions are non-inflammatory in origin. The most gen-

ially accepted explanation is that of Warthin, indorsed by Opie. They feel that buds of pancreatic tissue from the main ducts are snared off by the mesoderm of the gut and are carried away from their original site by the longitudinal growth of the intestine. This explanation seems most plausible for, as Simpson states, pancreatic tissue is never found elsewhere than along the derivatives of the foregut.

Location—There are, in general, two types of aberrant pancreas—annular pancreas situated normally but encircling the duodenum and small nodules of pancreatic tissue, varying from several mm to 6 cm or more in diameter, found on the wall of the stomach, pylorus, duodenum or jejunum. Nodules have also been found on intestinal diverticula, the hepatic duct, gall-bladder or omentum and in the region of the umbilicus. Nodules are most frequently found on the jejunum, and in about one-third of the cases the nodules have been found on the wall of the stomach.

Anatomy—Aberrant pancreatic tissue is usually found between the serosa and mucosa, the cells usually being interspersed among the muscle bundles. Growth may cause formation of a polyp in the lumen or an adenoma on the surface of the viscus depending on the direction of greatest proliferation of cells. Growth may spread the muscle, the cells pushing out to the surface, forming a roughened mass which is stippled in appearance and resembles an indurated peptic ulcer except that there is no definite crater.

Histology—Examination of a microscopical section leaves no doubt as to the diagnosis, for typical pancreatic tissue is always present. Acini are usually seen and there may be islands of Langerhans. Large and small ducts are often present and in some cases, these ducts have been demonstrated to communicate with the lumen of the gut. The cells appear quite normal and usually contain zymogen granules so that it seems logical to suppose that secretory function is present. This is also borne out by finding occasional areas of fat necrosis.

Surgical Complications and Potentialities—The complications arising due to the presence of aberrant pancreatic tissue may be grouped into three large divisions—mechanical, inflammatory and neoplastic.

Mechanical—The most obvious mechanical complication is duodenal stenosis due to the presence of an annular pancreas although obstruction may occur in the pylorus, duodenum, or jejunum, due to a large aberrant mass of pancreatic cells which has pushed into the lumen and has become pedunculated. These pedunculated polypoid masses also may cause intussusception and this is most frequently seen in the jejunum. Again, interfering with the normal duodenal mechanism or acting as a source of irritation may give rise to upper abdominal symptoms. Hale¹³ goes so far as to postulate the presence of pancreatic tissue in the pyloric ring in every case of congenital pyloric stenosis. Aberrant pancreatic tissue growing toward the serosa has been said to cause diverticula but it seems more probable that pancreatic rests have developed along the course of aberrant pancreatic ducts which have been interpreted as diverticula.

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Inflammatory—Chronic interstitial pancreatitis with or without localized fat necrosis has been reported in aberrant pancreatic tissue and absence of ducts for carrying away secretions has been given as an explanation of this pathology. Acute pancreatitis has also been observed, the etiology being as obscure as that of acute pancreatitis in the main gland. Placques of aberrant tissue have been thought to be a causative factor in the production of peptic ulcer by the proteolytic action of the secretion and this is a point which deserves more consideration than is usually given it.

Neoplastic—Carcinomatous degeneration of aberrant pancreatic tissue is reported as a final result in some cases. Bookman¹ reports a case of duodenal carcinoma which he feels undoubtedly arose in such a manner. The history was not typical of duodenal ulcer, there was a low gastric acidity and atypical pain with the presence of a definite filling defect on roentgen studies. Laparotomy showed an extensive malignancy and microscopical section showed pancreatic cells as the origin. Cabot³ reports a death from generalized carcinomatosis, the primary source being a widespread lesion in the stomach wall without ulceration of the mucosa. Microscopical section showed the origin as probably coming from a pancreatic nest in the gastric wall.

The following two cases are reported because the patients presented clinical symptoms rather characteristic of biliary-tract disease, yet removal of aberrant pancreatic tissue from the region near the pylorus by anterior hemipylorectomy has resulted in apparent cure.

CASE I—Mrs. H. F., aged twenty-five, entered the hospital April 12, 1933. *Present Illness*—Four years previous to admission the patient began to have sharp attacks of severe pain in the right hypochondrium and epigastrium. The pain radiated around to the back but never went up to the shoulder. Greasy foods seemed to bring on attacks but lean meats were the most provocative. The pain was colicky in type, causing the patient to toss from side to side. Some attacks were so severe as to require morphine for relief. Vomiting accompanied some attacks but did not give relief, nor was the pain relieved by food or soda. There seemed to be excessive gas formation but she was not able to belch. Mild jaundice, especially of the sclerae, accompanied the attacks which came at first at considerable intervals and lasted from two hours to two days. Attacks had recently come more frequently, appearing about once every month but with no relation to menses.

Past History—Appendectomy and partial left oophorectomy six years previous to admission. Tonsillectomy five years before admission. Right oophorectomy and uterine suspension four and one-half years before admission. Right salpingectomy and ligation of left tube two years before admission. All operations at other hospitals. Periods began at seventeen and were always regular. Has had three children and during each pregnancy has been treated for diabetes mellitus, insulin being required. During intervals, no insulin has been used and there have been no dietary restrictions. Since the birth of last child, seven years prior to admission, periods have come every two weeks. There is moderate intermenstrual leucorrhœal discharge. Chronic constipation has been present for years.

Physical examination negative except for moderate tenderness over duodenal and gall-bladder area. Bilateral cervical laceration.

Laboratory—Blood-pressure, 120/76. Blood sugar, 87.2 per cent. Urine 1019, acid, few leucocytes and epithelial cells, no sugar. Blood Hæmoglobin, 80 per cent. red blood-cells, 4,860,000, white blood-cells, 5,800. Wassermann, negative.

Radiography—Moderately dense gall-bladder shadow after dye ingestion, gall-bladder lying close under liver and tip reaching fourth lumbar vertebra No visualized calculi

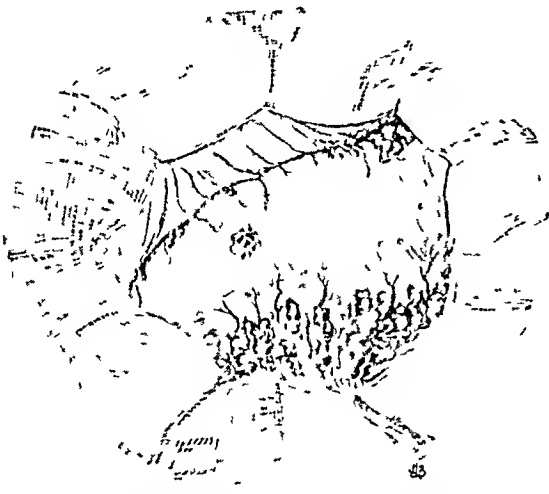


FIG 1—Appearance of the indurated area just on the duodenal side of the pyloric ring



FIG 2—Transverse incisions just to either side of the pylorus and beyond the tumor margin are made Dotted line indicates the connecting incision The angle sutures have been placed

Decrease in size by one-half following fat meal Liver moderately enlarged *Postoperative Diagnosis*—Chronic cholecystitis and cholelithiasis

Operative Procedure—Upper right rectus incision was made and peritoneal cavity

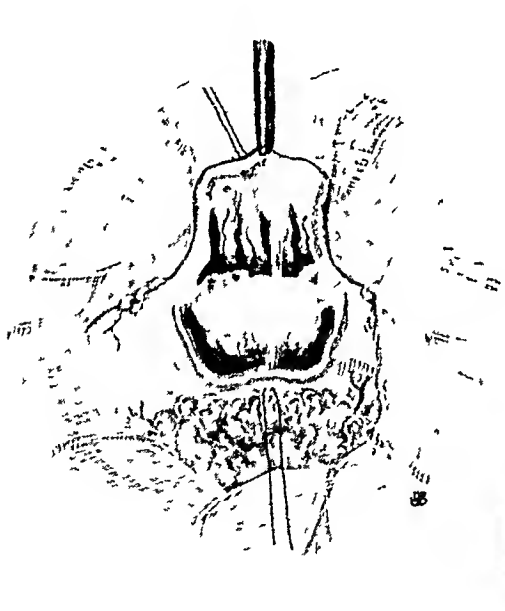


FIG 3—The flap of tissue consisting of pyloric ring, small amount of pyloric end of stomach and duodenum with the pancreatic tumor tissue about to be removed

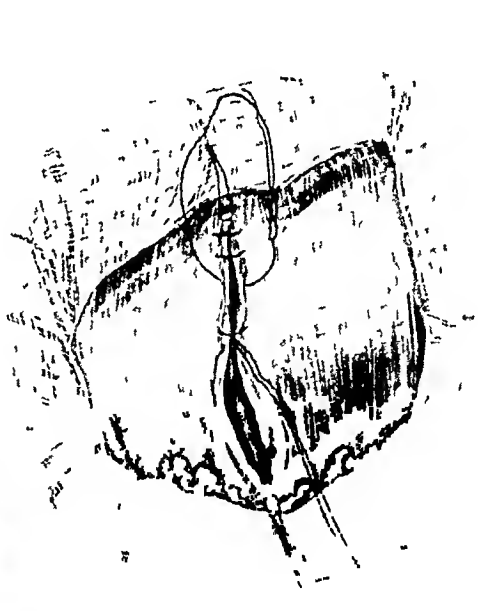


FIG 4—The first layer is a continuous through and through No 0 chromic catgut suture The suture comes out between the edges of the mucous membrane, thus assisting the inversion (Mikulicz) Over this a continuous Lembert No 0 chromic catgut suture is placed

opened A hyperplastic stippled area about 1 centimetre in diameter on anterior surface of duodenum just distal to pylorus immediately presented itself in wound Gall-bladder was thin-walled, normal in color and did not contain palpable stones Ducts were easily

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palpable and no stones found. No adhesions but some constriction near mid-portion of gall-bladder. Diagnosis of duodenal ulcer with hyperplasia of the tissue was made and hyperplastic area was excised together with part of pyloric muscle. Anterior hemipylorotomy was done after posterior wall was shown to be free of ulcer. Wound closed in layers. The question of adenoma or pancreatic lesion was in a passing way considered.

Post-operative Care—Nothing by mouth for forty-eight hours and then began second week Sippy diet. Pulse and temperature not remarkable and very slight pain. Post-operative course subsequently not remarkable. Fractional gastric analysis on the fourteenth post-operative day showed free 0, 0, 2, 12, 19, 32, and total 14, 10, 9, 15, 20, 41, 53. Dismissed on seventeenth post-operative day, having had no attacks of colicky pain although these should have returned with the Sippy diet of milk and cream had cholecystitis been present.

Pathological Report—Specimen consists of mass of firm tissue 1 by 1 by 1 centimetre. No active inflammatory reaction and grossly resembles scar tissue. Microscopical section shows wall of duodenum, covered on surface by normal appearing mucosa with deep layer of Brunner's glands. Wall is distorted by number of masses of glandular tissue which lie between muscle bundles. Some of these penetrate deeply through wall and lie beneath the serosa. Numerous ducts, although opening of ducts into lumen of bowel not visualized. Glandular tissue entirely characteristic of pancreas and, in addition, few islands of Langerhans are imbedded in the mass. No inflammatory reaction or scarring.

Final Diagnosis—Pancreatic tissue in duodenal wall. *Follow-up*—At the end of six months, patient reported she was feeling fine with no return of symptoms.

CASE II—Miss K. A., aged thirty-one, entered the hospital September 4, 1933. *Present Illness*—During ten years previous to admission patient has suffered with mild but rather chronic indigestion, accompanied by belching of gas, heartburn, upper abdominal distress, but no nausea or vomiting. Patient always felt better if she avoided greasy foods and rich pastries. Food did not give relief but at times soda did. Meat seemed to bring on distress although small amounts of white meat of chicken or small amounts of fresh fish did not seem to cause any disturbance. Rough foods caused distress. She always had a tendency toward constipation but kept herself fairly well regulated with mineral oil. Always seemed to feel better if she could expel gas although she did not get complete relief from upper abdominal distress. *Past History*—Tonsillectomy seven years ago. No other serious illnesses or operations.

Physical Examination—Essentially negative except for moderate tenderness just to the right and above umbilicus. No muscle rigidity. Slight tenderness over appendix.

Laboratory—Blood-pressure, 130/84. Urine 1020, acid, no albumin or sugar, microscopic negative. Blood Hæmoglobin, 90 per cent, red blood-cells, 4,300,000, white blood-cells, 7,200. Wassermann, negative. Gastric analysis Free 0, 0, 8, 16, 20, 30, total 12, 18, 26, 30, 42, 40.

Radiography—Gall-bladder fills well, empties readily, no visible calculi. Stomach showed no abnormality. Duodenum showed tendency toward momentary spasm in region of bulb. Slight irregularity at one point which was rather constant but no ulcer niche could be made out. Colon negative.

Pri-operative Diagnosis—Appendix dyspepsia. Cholecystitis? Duodenal ulcer?

Operative Procedure—Rectus incision just to the right of umbilicus. A free appendix, not abnormally long or with any gross pathology, immediately presented itself. The gall-bladder was then explored, found to be normal in color. No stones in gall-bladder or ducts. Duodenum was free and on the pylorus was a thickening which was raised about 2 millimetres and measured about 8 millimetres in diameter. There was no scar and no stippling typical of ulcer. This was considered to be accessory pancreatic tissue and anterior hemipylorotomy with excision of the tumor was done. Appendix removed.

Pathological Report—Specimen consisted of a mass of rather firm tissue measuring about 5 by 8 by 8. No active inflammatory reaction was present. Microscopical sections showed a portion of wall of duodenum with no destruction of overlying mucosa.

There were scattered areas of glandular tissue intermixed with some muscle fibre and they were characteristic of pancreatic tissue. Several islands of Langerhans were seen.

Final Diagnosis—Pancreatic tissue in duodenal wall. *Follow-up*—Three months after operation, patient reported that she was entirely relieved of previous symptoms and had never felt better.

Discussion—Cases in which there is aberrant pancreatic tissue and which present symptoms are usually diagnosed as peptic ulcer, cholecystitis or malignancy, although the history and findings are rarely typical of any of these conditions. Usually the patient complains of pain in the right upper quadrant, at times severe enough to simulate gall-bladder colic, but usually mild enough to be taken for the pain of ulcer although the meal-sequence and food-relief are absent in most cases. Meat seems to be the one food which most often aggravates or brings on pain and this is explained on the grounds that protein is the greatest stimulus to pancreatic activity. Aversion to fatty or greasy foods is usually present. Poor gall-bladder function as shown by cholecystography is sometimes found and it may be argued that this also is congenital because one embryological defect is seldom found singly. Low gastric acidity has been reported in most cases and this may be of interest in relation to the peptic ulcers diagnosed in the presence of low or absent acid. Biopsy might possibly show these ulcers to have pancreatic cells at their base. Of the two cases reported in this paper, the first showed acids ranging in the upper limits of normal and the second case showed acids well within the limits of normal. In our first case, the presence of diabetes only during pregnancy has not been explained and in no other case reviewed has diabetes been reported.

Comments and Conclusions—(1) Report is made of two cases of aberrant pancreatic tissue on the duodenal wall in which it is hoped that clinical symptoms have been removed by excision of the nodule.

(2) Aberrant or accessory pancreas is an embryological defect but clinical symptoms appear late if at all.

(3) The condition, though not frequent, is a surgical problem and may be found to have considerable significance when it is more widely recognized and understood.

(4) Possibility of aberrant pancreatic tissue as an etiological factor in peptic ulcer or carcinomatous degeneration will bear investigation.

(5) Treatment should include complete excision of the aberrant tissue so as to prevent any chance of neoplastic inflammatory or mechanical complication. Anterior hemipylorotomy was the operation of choice in the above two cases.

(6) Aberrant pancreatic tissue is usually diagnosed clinically as cholecystitis, peptic ulcer or malignancy and in these conditions, aberrant pancreas should be considered as one of the differential diagnostic possibilities.

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THE CAROTID SINUS AS AN ETIOLOGICAL FACTOR IN SUDDEN ANÆSTHETIC DEATH*

BY T MCKEAN DOWNS, M D †

OF PHILADELPHIA, PA

PROBABLY most surgeons have seen the tragic accident of a death on the operating table, under N_2O and O_2 anæsthesia. I append the history of a typical case.

A middle-aged white woman presented a moderately advanced carcinoma of the breast. Careful pre-operative study revealed no pathological conditions other than the presenting lesion. The past history was good, the patient was of a phlegmatic disposition and not alarmed by the prospect of an operation. All her organs and systems functioned normally, as shown by physical and laboratory study, the blood-pressure, chemistry, and urinalysis were all normal, the accessible arteries soft, the heart and lungs normal. The usual pre-operative dose of morphine and atropine was given. The operation was a radical removal of the breast, with dissection of the axilla. In order, as I thought, to give the patient the benefit of the greatest safety, nitrous oxide was chosen as the anæsthetic. Induction was easy, without struggling, and a satisfactory level of anæsthesia was easily maintained. The patient's color, pulse, and respiration were good throughout. The blood-pressure was not noted while on the operating table.

The operation progressed without incident for about forty-five minutes. The tedious dissection of the axilla had been accomplished, the general condition remaining satisfactory, and the mass of tissue was almost removed, when, with no warning, respiration abruptly stopped. There was no mucus in the throat, no gasping, no heaving of the chest in respiratory efforts rendered futile by some obstruction to the air passages. Nor did the respirations slowly diminish until they died out. The rhythm continued regular in rate and amplitude till the last breath, moreover, the color remained good. The heart continued to beat, at first quite forcefully, then gradually faded out till it, too, stopped about an hour and a half after the breathing. During all this time artificial respiration was continued, and every means which might conceivably stimulate respiration was tried. Dilatation of the sphincter, traction of the tongue, application of cold to the chest, inhalations of CO_2 were ineffectual, and a long list of stimulant drugs were injected—all to absolutely no avail. It was impossible to obtain any response from any measure that was tried, and the effort was abandoned only when the heart ultimately failed.

This is not an isolated instance, for I have knowledge of six similar fatalities, all unpublished, which have occurred in recent years. Doubtless there are others, for the tendency is rather to hush them up. The operations included four appendectomies, one for subacute appendicitis, one hemorrhaphy, and one breast amputation.

The circumstances surrounding the deaths of all the patients I know of at first hand were very similar. In all of the cases the patients had been well studied, and all their systems were functioning normally, as shown by

* Read before the Philadelphia Academy of Surgery, May 1, 1933.

† The experiments herein reported were performed in the Laboratory of Pharmacology, University of Pennsylvania, through the courtesy of Prof. A. U. Richards. They were suggested by Prof. C. F. Schmidt, and conducted with his constant advice and criticism.

physical examination and laboratory studies. In each case the period of anæsthesia was normal, with no notable excitement or struggling, and the color was good throughout. In all cases the anæsthetic period was not unduly long, the longest period before death was about forty-five minutes—consequently the calamity occurred after the use of a comparatively moderate amount of gas. Most striking of all, there was never any warning of the approach of the fatal termination—no gasping, no change in either rate or depth of respiration, no futile efforts to breathe—merely a sudden, complete and permanent respiratory failure, with the heart continuing to beat more or less regularly in some cases for hours. Also never were any of the measures of resuscitation of any use. Caffeine, strychnine, atropine, digalen, adrenalin, lobelin, carbon dioxide and oxygen, dilatation of the sphincter, traction of the tongue—all alike were useless. Artificial respiration merely postponed the inevitable. Cardiac massage was not tried in any of these cases, but would not seem useful inasmuch as the heart beat continues.

What can be the cause of these tragic accidents? The possibilities that occur to me are (1) Poor general condition (2) Embolism medulla brain—lungs (3) Hæmorrhage, in the medulla or brain (4) Improper administration of the anæsthetic (5) Impurities in the gases used (6) Asphyxia (7) Some toxic action of N_2O , which paralyzes the respiratory centre.

I will take them up in turn.

(1) Poor general condition cannot apply. In all these cases the patients were in good general condition as far as could be determined by careful pre-operative study of the organism as a whole.

(2) Cerebral embolism seems a plausible reason for sudden death, especially in the breast-amputation case, where very numerous blood-vessels are cut and tied. Yet for an embolus to pass from the operative area to the medulla, it must traverse the lesser circulation, where the capillaries of the lungs filter out all except the most minute of microscopical emboli—hardly larger, in fact, than a red blood cell. It seems incredible that a mass small enough to traverse the lungs should yet be large enough to cause a fatal embolism in the brain. Respiration does not cease abruptly in pulmonary embolism, even in the comparatively sudden deaths, there are at least several minutes of great distress, with respiratory embarrassment, with the heart failing at about the same time as the respiration. This also requires a very large clot to close the pulmonary artery completely—larger than can come from the operative area—and there seems insufficient time for a thrombus to be built up in the pulmonary circulation. In the only case autopsied, no embolus was present.

(3) Cerebral hæmorrhage hardly seems to be a possibility, although only one of this group was autopsied. Yet the patients were all in good condition beforehand, all were comparatively young, with soft elastic arteries and normal blood-pressures. One case, whose death was even more sudden than usual, at autopsy showed no gross pathology in any part of his

brain No sections were made, but it seems impossible that a lesion, invisible grossly, should yet exist and be so quickly fatal

(4) Improper administration of the anæsthetic is a possible cause of death in some patients, but I think does not apply to the cases I have studied The anæsthesia in all these cases was well conducted by people of good training and large experience

(5) Impurities in the gases used Although no chemical tests were made of the gases, I think the therapeutic test was convincing Every in-

dividual death occurred with a different tank of gas—no two deaths with gas from one cylinder In no case did a fatality occur either the first or the last time a tank was used Every tank both of nitrous oxide and of oxygen was used for a satisfactory anæsthesia both before and after the accidents occurred If impurities of the gases had caused death, there should have been other accidents from the use of those same tanks, and the accidents should have begun with the first use of the tank

(6) Asphyxia did not cause death In all the patients the color was good and the blood well oxygenated at the time of death, and asphyxia was not present In one patient of this group a moderate degree of cyanosis appeared during induction—about the same depth as is so common during induction of N_2O and O_2 anæsthesia If death had occurred from asphyxia, it should have occurred early in the induction when an anoxæmia was undoubtedly present The symptoms of

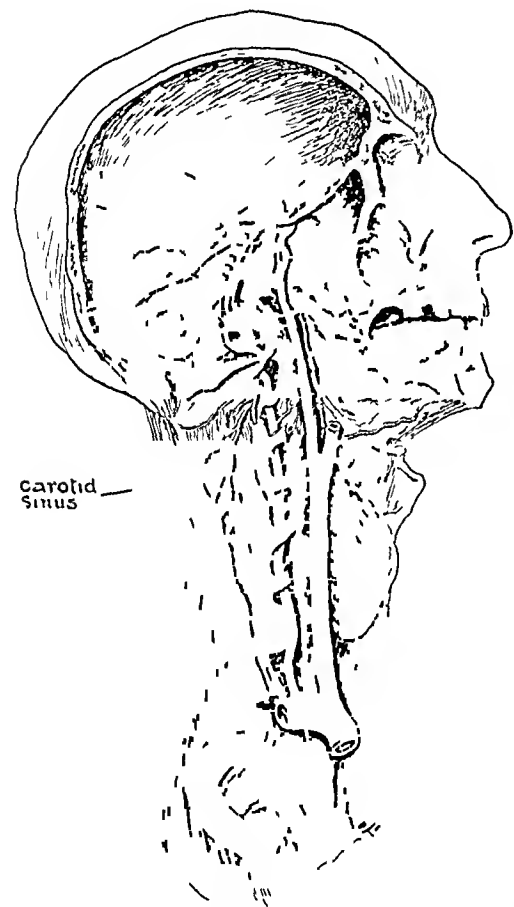


FIG 1—Showing location of carotid sinus at root of internal carotid artery, behind and below angle of jaw

asphyxia also were absent, confirming the information given by the color of the blood In asphyxia, breathing does not cease without warning There is a free secretion of mucus, the respirations become more and more stertorous and labored, and a tetanic rigidity sets in just before breathing stops In other cases where the asphyxia develops less rapidly, the patient becomes pale, and the respirations grow more and more shallow until they cease

Nothing of the kind was present in the cases I report Anæsthesia was satisfactory, reflexes were present, the color was good and respirations were regular and full Suddenly, with no warning, they stopped—the regular

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rhythm of breathing was interrupted and was never resumed. Nor were there any, even faint, gasps or respiratory efforts afterward. Merely inertia, and a heart which gradually failed and whose action became more and more irregular after a period of artificial respiration, until it, too, ceased.

(7) The conclusion is to me unescapable, that nitrous oxide itself has a toxic action. This toxicity has not been reported in animals, nor is it common in humans. In fact, nitrous oxide is generally considered to have no toxic action, even its anæsthetic action is supposed by many to be due wholly to asphyxia or anoxæmia.

In the hope of throwing light on this question, some animal experiments were undertaken in the Laboratory of Pharmacology at the University of

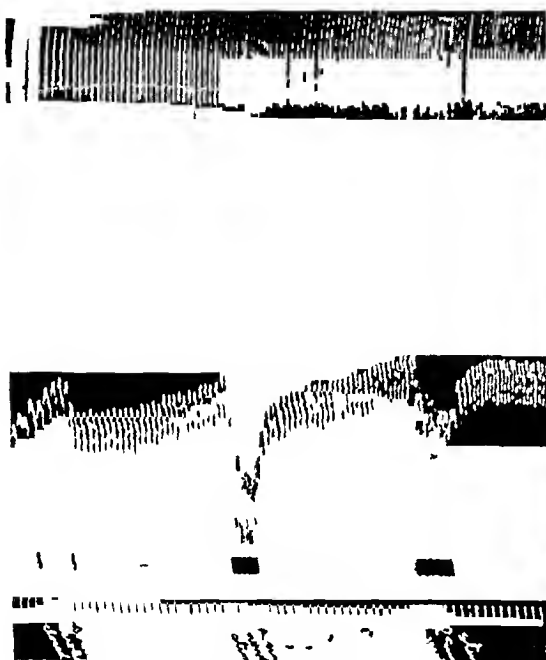


FIG 2—Upper tracing—pneumograph. Middle—blood pressure in femoral artery, zero at signal line. Lowest—time marker, five seconds. Shows rise in blood pressure and slowing respiration when endosinusal pressure is reduced to zero. Followed by fall in systemic blood pressure and dyspnoea on electrical stimulation of each sinus nerve.

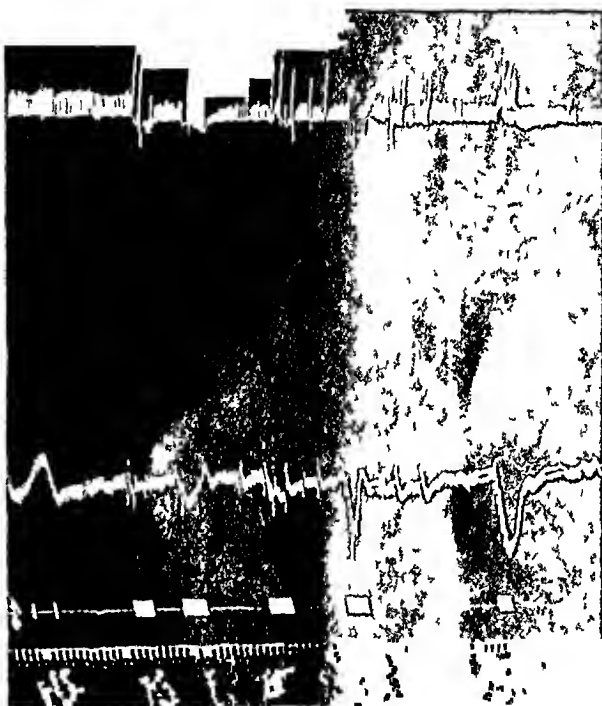


FIG 3—From above down—pneumograph tracing, blood pressure in femoral artery, blood pressure zero and signal line, time marker, five seconds. Showing contrasting effects of stimulating vagus and sinus nerves. On strong vagal stimulation, blood pressure drops sharply, but soon escapes from the stimulus, respiration also very slow or absent. On sinus stimulation, blood pressure does not escape, and there is marked dyspnoea.

Pennsylvania. The carotid sinus has been shown by Hering, of Cologne, to be of great importance in the normal regulation of blood-pressure and circulation, Heymans and his associates, of Ghent, and C. F. Schmidt, of the University of Pennsylvania, subsequently demonstrated also that respiration is affected by afferent impulses coming from that organ. It therefore seemed worth while to see whether the accidents under nitrous oxide might be due to a perversion of the respiratory or circulatory reflex function of the sinuses.

The carotid sinus or bulb is a dilatation of the root of the internal carotid artery (Fig. 1) which is sharply localized and is distinguished his-

tologically from the ordinary arterial wall by being thinner, and by possessing in its adventitia a rich arborescence of nerves and sensory end-organs (De Castro Trav lab de Rech Biol de L'Univers de Madrid, vol 24, pp 365-430, 1926 *Ibid*, vol 25, pp 331-378, 1927-1928) It is connected to the brain by its own special nerve, which is a branch of the glos-

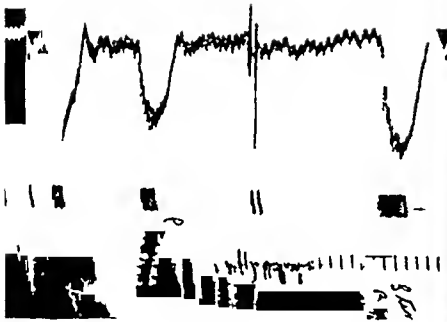


FIG 4

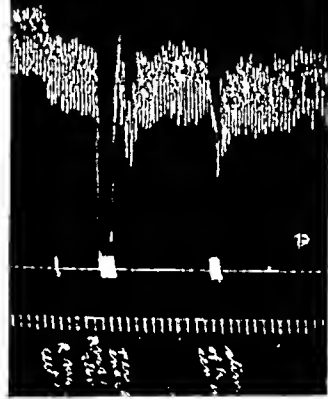


FIG 5

FIG 4—From above down—pneumograph, blood pressure in femoral artery, blood pressure zero and signal line, time marker, five seconds. An other example of dyspnoea on stimulation of sinus nerves, contrasted with apnoea on vagal stimulation.

FIG 5—From above down—pneumograph, blood pressure in femoral artery, blood pressure zero and signal line, time marker, five seconds. Shows stimulation of stumps of cut vagus, peripheral end causes cardiac arrest, without respiratory change. Of central stump, apnoea, with very slight circulatory change.

sopharyngeal. The sinus is in a state of constant tonus (Blouk and Stella Proc Soc Exp Biol and Med, vol 29, pp 443-445, January, 1932, Bronk, *Ibid*, vol 28, p 1014, June, 1931) which increases or diminishes with varying arterial pressure within it, or which can be varied by a variety of other stimuli, especially by pressure on its wall, or by electrical stimulation of its nerve (Fig 2).

It is also known that the function of the sinus can be augmented or

diminished by the action of various drugs. Morphine, for example, increases the reflex response on stimulation of the sinus or its nerve, and the well-known bradycardia following the administration of morphine and digitalis fails to occur if the sinus nerves are cut (Koch). Few studies have been made of the effect of the inhalation anæsthetics, yet either has been found to abolish the reflex (Florey and Marvin), while it is increased under chloroform. When chloroform narcosis is pushed to dangerous levels, the sinus reflex persists longer than the corneal.

In fact, the familiar though misnamed "vagal pressure" of the cardiologists is actually pressure on the carotid sinus (Figs 3, 4 and 5). Stimulation of the sinus or its nerve causes a fall of blood-pressure with bradycardia, with increase in the rate and depth of respiration (Fig 6).

No experiments have been reported dealing with the effect of nitrous oxide on these reflexes. Consequently, it seemed of scientific interest, and possibly of practical importance to examine the matter.

In a series of nineteen dogs under anæsthesia by N_2O and O_2 , the carotid sinuses were stimulated in various ways. Five dogs for one reason or another were unsuitable subjects and are not included. In seven of the remaining animals stimulation of the sinuses or of the sinus nerves produced a sudden transitory fall in blood-pressure, as was expected, but this was accompanied by a cessation of respiration, which in one case lasted thirty-nine minutes.

The gas used was nitrous oxide of USP quality, especially prepared for anæsthesia, and was administered with oxygen by Gwathmey's apparatus. The proportion used was as nearly as possible 20 per cent nitrous oxide, 80 per cent oxygen. In some experiments, a face mask was used, in other cases the gas mixture was delivered directly into a tracheal cannula, properly protected by valves. In most cases, rebreathing was not made use of, but in one experiment a glass tube of a capacity of fifty cubic centimetres was attached to the tracheal cannula. This brought the respiratory dead space

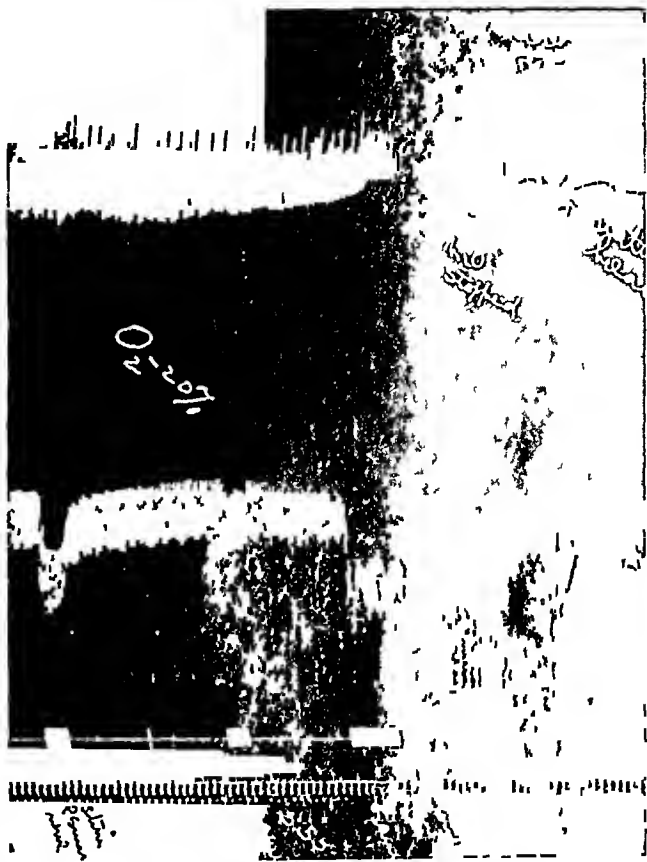


FIG 6—From above down—pneumograph, blood pressure in femoral artery, blood pressure zero and signal line, time marker, five seconds. Dog under anæsthesia— N_2O , 80 per cent, O_2 20 per cent. Several stimulations of sinus nerve give no effect. Then stimulation causes profound fall in blood pressure and apnoea. Artificial respiration, with recovery. Cutting the sinus nerve did not change the reaction.

approximately to what it is in the intact animal, and compensated for the volume of the trachea and pharynx short-circuited by the cannula. In a few experiments, the dog was forced to breathe against a pressure of ten centimetres of water, thinking that by raising the intrapulmonary pressure in this way more oxygen would be absorbed, and the anaesthesia would be smoother. This failed to be the case, for the dogs were usually unable to expire against the increased pressure, and became asphyxiated.

The first experiment was the most striking of all. This dog was prepared by exposing both common carotid arteries, blood-pressure, as in all cases was taken in the femoral artery, and a pneumograph tracing was made. Gas and oxygen were supplied through a mask provided with valves, that did not permit rebreathing. The sinuses were shown to be active before nitrous oxide was started, under anaesthesia they were again tested a few times by clamping the two carotid arteries. This, by allowing the endosinusal pressure to fall to zero, produced reflexly a great rise in blood-pressure, of about fifty millimetres mercury. The second time this was repeated, when the carotid arteries were released, the pulse became very slow and irregular, blood-pressure dropped precipitously, and respirations stopped for a period, artificial respiration resuscitated the animal.

This result was so striking, and followed so closely on releasing the pressure on the common carotids, that it was sought for several times. At each trial the same thing happened. After fifteen to twenty minutes of anaesthesia, release of carotid occlusion was instantly followed by great slowing or temporary arrest of the heart, profound fall in blood-pressure, and an apnoeic period of varying length—from one minute to as long as eight and one-half minutes. Artificial respiration with pure oxygen was employed in this last case to prevent a fatal asphyxia, for the dog made no respiratory effort. After a short period, the pulse rate and blood-pressure returned to normal or even above if asphyxia was allowed to become marked. In each instance, as soon as the gas mask was removed and the animal was breathing air or oxygen, this occlusion had no unexpected results, and release of occlusion was followed by resumption of normal blood-pressure.

The stimulus for this unexpected result seemed to be the sudden distention of the carotid sinus by blood under high pressure—a sort of hammer blow—when the arterial occlusion was released. To see whether other forms of stimulation of the sinus would be effective traction on the common carotid was tried, for Hering has shown this to be an effectual stimulant of the sinus. During twenty minutes this was tried several times, at the end of that time, traction on the right carotid artery caused apnoea lasting one minute, great slowing of the heart, and a fall in blood-pressure to about twenty-five millimetres—a fall of about eighty millimetres.

By this time the dog's condition had become bad, and the experiment was terminated. It may be said in passing that though this response was elicited many times on numerous other dogs by stimulating the sinuses or their nerves in many different ways, yet on no other occasion could it be gotten by releasing the closed carotid arteries.

This sudden respiratory failure was so unexpected and so striking that this first experiment was repeated, but repeated closure of the common carotids failed to produce apnoea. It was therefore determined to try the effect of pressure on the carotid sinuses—the so-called vagal pressure experiment of Czermak. An animal whose blood-pressure had been steady for some time at about 100 millimetres of mercury, and both sinuses were active was given Nitrous oxide and oxygen when the blood-pressure rose gradually to 122, and then to 132 on closing the carotids. Stimulation of the right sinus nerve caused a fall of pressure to 110 millimetres. After twenty-six minutes of anaesthesia, while firm pressure on the right carotid sinus for forty seconds caused great inhibition of the heart.

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rate, precipitous fall of blood-pressure to sixty millimetres and to fifty millimetres two minutes later with total apnoea. This lasted for three and one-half minutes but it required three minutes longer before respiration was normal again. This long period injured the animal, and it was impossible to resume the anæsthesia, though the various sinus reflexes were all normal.

This experiment was repeated on a dog who suffered with well-marked chorea. The choreiform movements disappeared only under deep gas anæsthesia, and caused great irregularities in the tracing, particularly while the subject was fresh. The sinuses, however, were very active, closure of both common carotids caused the blood-pressure to rise from 125 to 170, pressure on the sinuses produced a fall of pressure to 100 millimetres. Any influence on respiration was not noticeable, due to the chorea. After the nitrous oxide and oxygen had been started, carotid closure raised the blood-pressure to 200 millimetres. After the gas had been flowing thirty minutes, pressure on the right

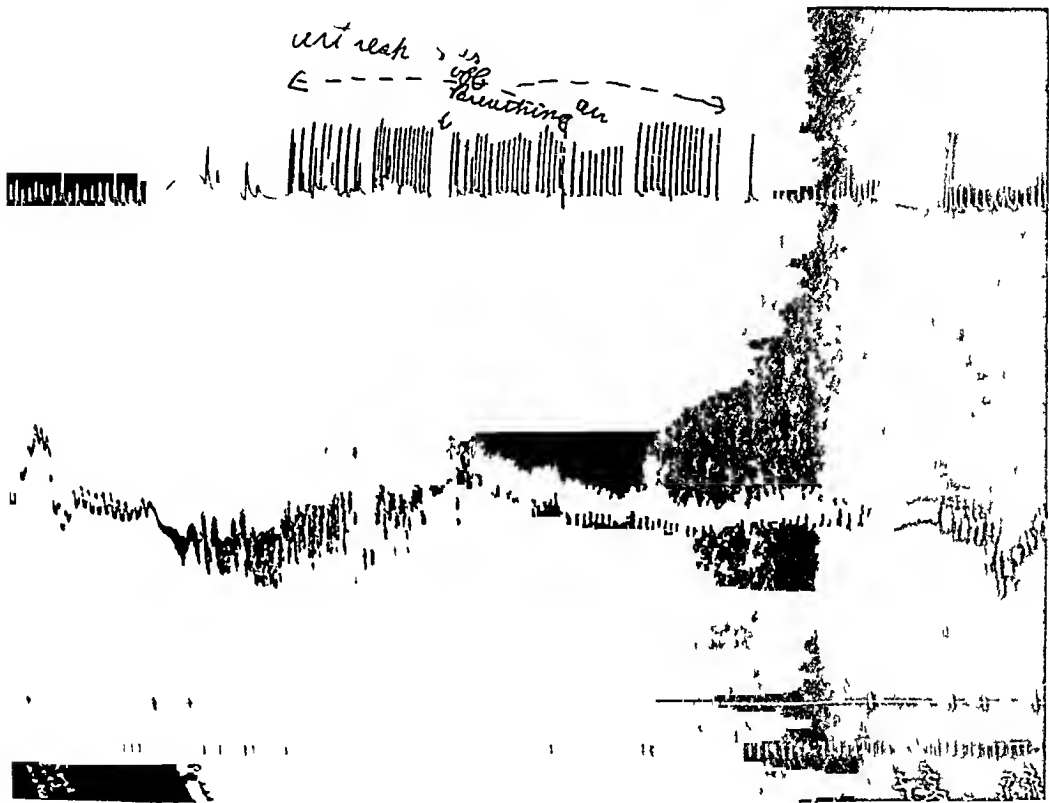


FIG 7—Tracings, see other figs for explanation. Pressure on right carotid sinus causes fall in blood pressure and bradycardia, with apnoea, lasting over five minutes. Artificial respiration continued the circulation in good condition. After recovery, pressure on larynx caused mechanical obstruction to breathing, stimulation of inferior laryngeal nerve caused slight circulatory change, no change in respiration. Dog under N_2O and O_2 anæsthesia as before.

carotid sinus, maintained for one minute and forty-five seconds, caused marked transitory fall in the blood-pressure with cardiac irregularity and slowing, and apnoea. After four minutes, one deep respiratory movement was made, and two minutes later respiration was re-established, at first very slow, deep and irregular. Finally breathing and circulation settled down to normal after a total of twelve minutes. An hour or more was now allowed for recovery, then the gas was started again, after seeing that the sinuses were still active. This time after only eight minutes of anæsthesia, pressure on the right sinus for twenty seconds produced the same circulatory collapse and apnoea lasting five minutes (Fig 7). Since it had been suggested the apnoea might have been due to mechanical interference with respiration, the larynx was now strongly pulled to one side, so far as to obstruct the airway. There were no circulatory changes with this, and breathing stopped only until the airway was re-established.

The next experiment in which positive results were obtained was most striking. In this case, after proving the activity of the preparation, nitrous oxide and oxygen were given with a mask. The blood-pressure gradually rose from 100 to 140, respirations unchanged at about twelve per minute. After fifty minutes of anæsthesia,

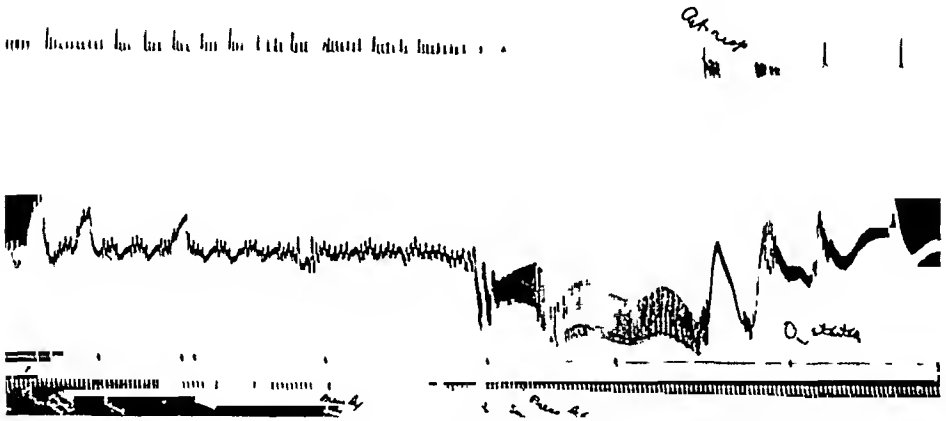


FIG 8--Tracings as before. Dog under N_2O and O_2 anæsthesia as before. After stimulating the sinus apparatus in various ways, at 12.01 P.M. firm pressure was made on left carotid sinus and held for one minute, forty five seconds. Immediate apnoea, great fall in blood pressure and bradycardia, which soon recovered. Occasional respiratory movement, blood pressure rising and irregular as result of asphyxia.

pressure on the right carotid sinus caused sudden circulatory collapse, with apnoea. The pressure was continued two minutes, fifteen seconds, artificial respiration was started after four minutes, and was continued with frequent interruptions (Figs 8, 9 and 10). Finally, after forty minutes, breathing was resumed. During all this period, the circulation remained satisfactory, the blood-pressure holding steady at 110 millimetres until just before the end of the apnoea, when it slowly dropped to ninety.

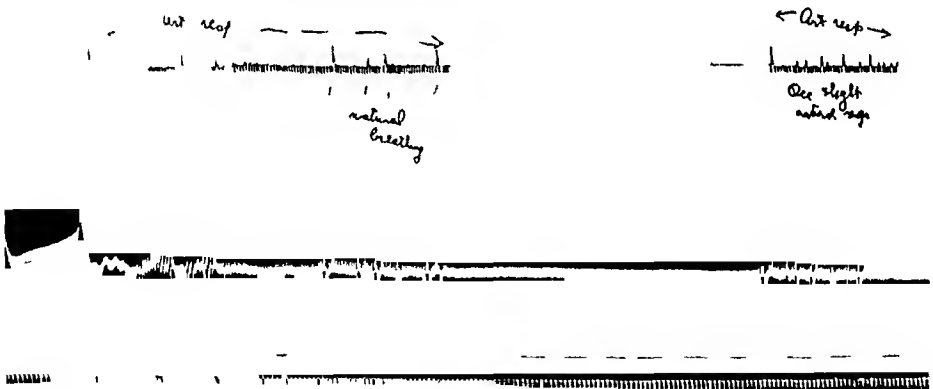


FIG 9—Continuation of Fig 8. Artificial respiration used from time to time the apnoeic interval shown is over five minutes, with no respiratory effort. However, pulse and blood pressure remain satisfactory.

One and one-half hours were now allowed for recovery, during which the sinuses were exposed and superior laryngeal nerves were cut. Gas in the usual proportions with oxygen was started (N_2O 80 per cent, O_2 20 per cent), but the nervous system had been injured, and breathing very soon stopped, apparently from asphyxia. This was re-established, and after a rest, the proportion of oxygen was increased to 33 per cent. The general condition remained unsatisfactory, with irregular blood-pressure.

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Finally, traction on the left carotid caused circulatory collapse with apnœa, but the heart also stopped and could not be started again. Doubtless the former prolonged apnœa had damaged the tissues.

Till now, the apnœa and circulatory collapse had resulted from stimulation of the carotid sinuses, it was now determined to stimulate the sinus nerve directly (See Fig 6). After eleven minutes of anæsthesia, stimulation of the left sinus nerve with a moderate current was done for thirty seconds, a circulatory collapse resulted, and apnœa lasting two minutes. The sinus nerve was cut as soon as the stimulus was withdrawn, but this had no effect on respiration, and artificial respiration was necessary.

After allowing a period of one-half hour for recovery, stimuli were applied to the vagi, for the effect in some ways resembled vagal stimulation. Stimulation of the peripheral end of each vagus separately caused great cardiac inhibition (see Figs 3, 4 and 5) which soon escaped from the stimulus. Stimulating the central end of each vagus caused apnœa, which lasted only until the stimulus was withdrawn.

A final experiment may be quoted, in which, after twenty minutes of anæsthesia,

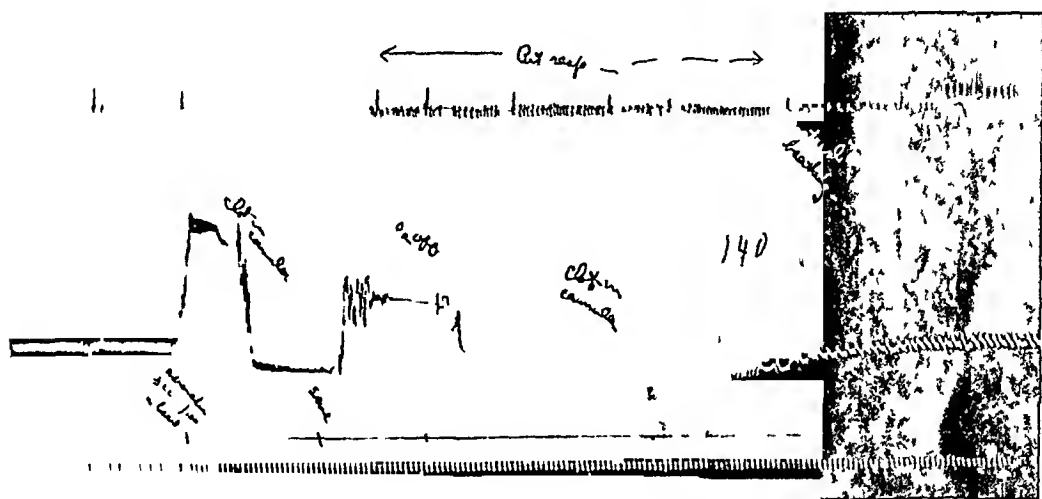


FIG 10—Continuation of Figs 8 and 9. Begins with an apnœic period of over six minutes, with only two slight respiratory attempts. Intracardiac adrenalin has no stimulating effect on respiration. Blood pressure tracing obscured, due to formation of a clot in the cannula. When this is cleared out, blood pressure low, but rising under the influence of artificial respiration. The total time until natural breathing resumed was thirty-nine minutes.

stimulation of the left sinus nerve produced temporary circulatory collapse, and apnœa lasting three and one-half minutes. After allowing a period of forty-five minutes for recovery, stimulation of the opposite nerve was effective, but this time the circulatory disturbance was fatal. However, the heart did not stop until some time after the respiration. The sinus nerves were cut as the circulation collapsed, but without influence on the condition.

This respiratory arrest and temporary circulatory collapse seems to us to be similar to the fatal respiratory failure that occasionally overtakes human patients in the operating room. The only apparent difference is that in dogs the respiration has been restored, while in the human this has been impossible. Doubtless the reason for this is the greater efficiency with which artificial respiration can be practised in small animals, especially forced mechanical ventilation of the lungs. Possibly a positive mechanical method such as the Drinker respirator, or something similar, would restore human patients. I have had no opportunity to try this.

The apnœa and temporary circulatory failure produced by stimulating

the carotid sinuses or their nerves occur under certain conditions only. Some of the conditions are known. It did not occur unless the anæsthesia had lasted at least 20 minutes. There seems to be some personal idiosyncrasy, for it cannot be produced in every dog. Although it is undoubtedly initiated reflexly, yet it is not wholly a reflex, for it continues after the stimulus has been removed (see Fig 6), even cutting the sinus nerves does not shorten the period of apnoea. In some ways, it resembles the respiratory failure that occurs in anoxæmia, yet a cerebral anoxæmia produced by closing the carotid arteries is not sufficient to cause respiratory failure, unless accompanied by stimulation of the carotid sinuses, as, for example, when the sinuses are stimulated by pressure.

The exact nature of this phenomenon is still obscure. It is not clear whether it is a perverted reflex due to the direct action of N_2O on the carotid sinus or central nervous system or whether it is a result of asphyxia, or a mixture of the two. Yet it seems that certain practical conclusions can be drawn which may help to avoid this calamity.

(1) In gas anæsthesia, pressure on the carotid sinus must be scrupulously avoided. In holding the gas mask tightly to the face, the anæsthetist makes considerable pressure, and for counter-pressure, and to hold the jaw forward, often hooks his fingers on the angle of the jaw. Just behind the angle is the dangerous point, it is believed that pressure of this kind is often a precipitating factor in sudden respiratory arrest.

(2) Florey and Marvin (*Jour Physiol*, vol 64, pp 318-323, February 10, 1928) have shown that ether diminishes the sensitivity of the carotid sinus. Therefore, ether vapor added to the gases not only stimulates respiration, but also minimizes the effect of any pressure that might accidentally occur.

(3) In case of accident, all drugs are useless. The only worthwhile treatment is artificial respiration. This, if carried out mechanically in a respirator, might prolong life until normal respirations could be resumed, though opportunity has not yet occurred to try this in the human.

SUMMARY—The occurrence of sudden respiratory failure in N_2O and O_2 anæsthesia has been described. It is shown that no yet known factor is responsible for this failure and that hitherto no treatment has been of any avail. Animal experiments are mentioned, in which this sudden arrest of respiration was duplicated by stimulation of the carotid sinuses in various ways. This experimental respiratory failure seemed in all respects comparable to that occurring clinically.

The suggestion is made (1) that this accident can be avoided by scrupulous care to avoid pressure on or just behind the angle of the jaw, (2) that the addition of ether vapor to the gas will render the sinus less responsive to any accidental pressure, and (3) that if respiratory failure should occur, mechanical artificial respiration with a respirator is the treatment which offers the best promise of success.

THE RELATION OF POST-OPERATIVE PARALYTIC ILEUS TO MORTALITY IN ACUTE APPENDICITIS *

BY PHILIP C POTTER, M D

OF NEW YORK, N Y

FROM THE DEPARTMENT OF SURGERY OF COLUMBIA UNIVERSITY AND THE FIRST SURGICAL DIVISION OF BELLEVUE HOSPITAL

THE term "paralytic ileus" is used in this paper to denote that terminal phase of small intestinal distention in which, as the result of accumulation of gas and toxic material within the lumen of the intestine and the resulting interference with blood supply, there is a complete loss of muscle tone. Clinically, paralytic ileus is characterized by prostration, extreme toxicity, failure of the intestinal musculature to respond to any form of stimulation, and early death. Paralytic ileus is preceded by varying grades of intestinal distention. Here muscle tone is still present as evidenced by attempts at contraction and response to stimuli. There is little interference with blood supply, and there is not the picture of marked toxicity. This is the stage of discomfort and is a source of danger only in that, if unrelieved, it may progress to the stage of true paralytic ileus. Post-operative distention may follow any intra-abdominal operative procedure but it is most commonly encountered in the presence of an intraperitoneal inflammatory process, especially where there is an associated peritonitis.

During the past four years a study has been carried on, on the wards of the First Surgical Division, Bellevue Hospital. The objects were: First, to determine the immediate causes of death in acute appendicitis, and second, to devise means for the avoidance of complications which might have a direct bearing on mortality. Our cases were classified into five groups:

- (1) Acute appendicitis
- (2) Acute appendicitis with acute local peritonitis
- (3) Acute appendicitis with peritoneal abscess
- (4) Acute appendicitis with acute diffuse peritonitis
- (5) Acute appendicitis with progressive fibrinopurulent peritonitis

In going over the records it was found that the mortality in groups 1 and 2 was low, as was to be expected. The most frequent complication was post-operative distention with accompanying gas pains. In group 3, the major complication was likewise paralytic distention, seconded by acute obstruction due to adherence of a loop of intestine to the abscess wall. The mortality in this group was somewhat higher. In groups 4 and 5, acute appendicitis with diffuse peritonitis and progressive fibrinopurulent peritonitis, the mortality was found to be distressingly high. For the period 1920-1930, inclusive, our diffuse peritonitis mortality averaged 30 per cent. This represented a total

* Read before the New York Academy of Medicine, Section of Surgery, January 6, 1933

of sixty-three cases with nineteen deaths. There were four cases of progressive fibrinopurulent peritonitis with four deaths. Thus, during this eleven-year period, there were twenty-three deaths from acute appendicitis with acute diffuse or fibrino-purulent peritonitis on the wards of the First Surgical Division. In analyzing these cases, it was found that in sixteen of the twenty-three, death was either the direct result of paralytic ileus or post-operative distention played a major rôle in the course of the disease. With these facts in mind it seemed reasonable to suppose that the elimination of paralytic ileus as a post-operative complication would result in a lowering of the mortality in these groups.

A preliminary report of this work appeared in September, 1932.* Here it was assumed that following any abdominal operation there was a period of hypotonia of the intestinal musculature of greater or less degree and duration. It was felt that if the normal tone could be maintained throughout this hypotonic period the smooth muscle of the intestinal wall would again assume its normal function and distention could be avoided. If measures were to be successful they must be in the nature of prophylaxis rather than a cure for the condition once it had arisen. Pituitrin was used in our first experiments a routine of six doses, the first given intramuscularly directly following operation and continued at intervals of four hours for six doses. It was soon found that whereas this scheme sufficed in many cases, notably early appendicitis, the dosage was not sufficiently prolonged to prevent distention in biliary cases and cases in which there was a complicating peritonitis. Also in certain cases distention appeared before the initial dose had been given.

In a second series composed of fifty biliary cases and fifty acute appendices, with and without peritonitis, the initial dose of pituitary was given before operation where general anaesthesia was used, directly following operation where spinal anaesthesia was employed. In this series "pitressin" was substituted for surgical pituitrin as it seemed more specific for our purpose in that it contained all the elements of the old pituitrin save the oxytocic or uterine. Clinically, there had been no evidence of increased peristalsis where pituitary extract had been given in the presence of normally contracted intestine. In twelve biliary cases observations were made in the open abdomen. There was a gradual shrinking of the small intestine coming on fifteen to twenty minutes after the intramuscular administration of pitressin. This was not peristaltic in nature, and was maintained throughout the operation. It produced an extremely "quiet" abdomen and made for an easy closure of the peritoneum. In this series of 100 cases there was no instance of paralytic ileus and only moderate distention in ten cases.

During the past eighteen months there have been 112 cases of acute appendicitis, with and without peritonitis. Of this number sixty-two were classified at operation as acute appendicitis, eight as acute appendicitis with local peri-

* Potter, Philip C, and Mueller, R. Sterling. Posterior Pituitary Extract in the Prevention of Post-operative Intestinal Distention. *ANNALS OF SURGERY*, vol. 96, p. 364, September, 1932.

ILEUS MORTALITY IN APPENDICITIS

tonitis, twenty-six as acute appendicitis with peritoneal abscess, fourteen as acute appendicitis with acute diffuse peritonitis, and two as acute appendicitis with progressive fibrinopurulent peritonitis. In this series pitressin was given as routine, one ampoule intramuscularly before operation where general anaesthesia was used, directly following operation with spinal anaesthesia. Groups 1 and 2 received an average of eight doses, group 3, twelve doses. In the diffuse peritonitis groups dosage was continued for considerably longer periods. In this series of 112 cases there was no instance of paralytic ileus. There were seven deaths, a mortality of 6 per cent. These deaths were confined to groups 3, 4 and 5, that is, the abscess and diffuse peritonitis groups. Among the twenty-six abscess cases there were four deaths, a mortality of 15 per cent. The first was due to a mechanical obstruction, relieved by enterostomy, but followed by massive pneumonia and death. This was confirmed at autopsy. In the second case, complicated by diabetes, there was a mesenteric thrombosis, likewise proved at autopsy. In the third case a mechanical obstruction developed at the site of the abscess. This was not relieved by ileostomy. Post-mortem revealed a double-loop obstruction, only one loop of which had been drained. The fourth death was in the case of a small boy with a large, well-walled-off abscess. Simple drainage was done. Within a few hours the temperature rose to 109° and death occurred in twelve hours. No autopsy was obtained.

Among the fourteen cases of acute diffuse peritonitis there were two deaths, a mortality of 14 per cent. In the first, a diffuse peritonitis with gangrene of appendix and adjoining caecum, a fecal fistula developed on the tenth day and there followed a slow death from sepsis. No autopsy was obtained. The second death was due to pneumonia and occurred on the fourth post-operative day.

There were two cases of fibrinopurulent peritonitis with one death. In this case jaundice appeared on the day following operation, and death occurred on the fourteenth day. Autopsy showed a diffuse fibrinopurulent peritonitis, subphrenic abscess, multiple liver abscesses and gangrene of the caecum. In no instance was death the result of paralytic ileus, nor did distention play an important rôle save where there existed a mechanical obstruction or a thrombosis.

During the past eighteen months pitressin has been employed prophylactically in 550 abdominal operations. In this series there has been no paralytic ileus. We have observed no so-called "pituitrin shock." It has been found that the presence of a post-operative pneumonitis neutralizes to a marked degree the effect of pituitary extract. In the event of this complication, pitressin is given every two hours instead of at four-hour intervals, with colon irrigations as indicated. In observing the acute diffuse peritonitis group it has been a source of surprise how little toxicity may result from the presence of large amounts of pus within the peritoneal cavity in the absence of distention. This was particularly striking in the case of fibrinopurulent peritonitis which recovered. At operation under spinal anaesthesia, a gangrenous

appendix and lower cæcum were found. There was thick colon pus throughout the right half of the abdomen and a large pelvic collection. The liver, gall-bladder and stomach were covered with plastic exudate. The intestinal coils were bright red and glued together by heavy plaques of fibrin. The appendix was removed and the lower cæcum turned in and sutured. On the tenth day, owing to a partial disruption of the wound, the abdomen was once more opened and the pathology found to be essentially the same as at the time of the first operation. In spite of the extensive involvement of the peritoneal cavity, this patient ran an unusually smooth course and was discharged on the twenty-ninth day.

Before closing, several points in technic should be emphasized. (1) Pitressin must be given intramuscularly, preferably into the deltoid. If given subcutaneously, it is often absorbed too slowly to produce the desired effect. (2) The initial dose must be given in the presence of non-distended intestine. Hence with general anæsthesia the first dose is given at the beginning of the operation. (3) The administration of pitressin must be continued at regular intervals throughout the "hypotonic period." This period varies in duration and no set rules can be laid down. However, it has been our experience that in early appendicitis without peritonitis, eight doses are sufficient. In biliary cases twelve doses are ordered. In several of our peritonitis cases we have continued the use of pitressin for two weeks or more. (4) No cathartics or enemas are given until pitressin has been discontinued. Following the final dose a colon irrigation is ordered. Finally it must be evident that the carrying out of any procedure such as the one outlined cannot be left entirely to the nursing staff. Periodic examination of the abdomen is necessary. Where early distention is noted, an additional ampoule of pitressin is ordered with a colon irrigation if necessary.

Summary—The highest mortality in acute appendicitis is in the diffuse peritonitis groups. Here a frequent cause of death is paralytic ileus. If paralytic ileus be excluded as a post-operative complication, a decrease in mortality may be expected in these groups. A method which has proved a safe and efficient means of excluding paralytic ileus as a post-operative complication is described.

NOTE—The series now (February, 1934) comprises 222 cases of acute appendicitis with and without peritonitis. There have been nine deaths, a mortality of 4 per cent. In the diffuse peritonitis group there have been twenty cases with three deaths, a mortality of 15 per cent.

FEMORAL HYDROCELE

BY JAMES DAVIDSON RIVES, M D

OF NEW ORLEANS, LA

FROM THE DEPARTMENT OF SURGERY OF THE LOUISIANA STATE UNIVERSITY MEDICAL CENTER
AND THE SURGICAL DEPARTMENT OF CHARITY HOSPITAL

ALMOST every abdominal viscus has been reported in the sacs of femoral herniæ, as well as various extraneous objects, and Murray and Keith have identified in the femoral canal numerous diverticula of the peritoneum which contained nothing at all. One hesitates, therefore, to attempt to add anything to the literature of the subject, particularly since there can be little doubt that many surgeons have seen instances of femoral hydrocele such as are herewith reported, even though they have not, it would seem, put them on record. At any rate, an exhaustive search of the most important textbooks and systems of surgery, as well as of the periodical literature through the Index Catalogue of the Surgeon General's Library and the Quarterly Cumulative Index Medicus, reveals no publication dealing with such a subject, if one is to judge from the title, except for the somewhat similar case reported by Bailey and quoted in full below. It seems justifiable, therefore, to put on the record two personal cases of femoral hydrocele from Charity Hospital in New Orleans.

CASE I—A colored woman, aged thirty-three years, was admitted to the hospital July 22, 1929, complaining of a tumor mass in the right groin. It had appeared five years before, as a small lump, and had grown steadily until it had attained its present size, at no time had it caused pain or other symptoms. The past history was irrelevant, the patient was not married and had never been pregnant, nor did she give a story of any illness of any sort. Physical examination was essentially negative except for a mass the size of a small hen's egg located in the right femoral triangle, it was freely movable, it was not attached to the skin at any point, it was not crepitant and not pulsating, and it gave the impression of being cystic. My own tentative diagnosis was *hygroma versus* soft lipoma. The interne commented on the fact that the location, the size and the shape of the mass justified a possible diagnosis of femoral hernia, and the course of events proved his surmise correct.

Operation was done July 25, under ether anesthesia. A curved incision was made parallel and inferior to Poupart's ligament, and the mass, which lay directly below the deep fascia, proved to be a very thin-walled cyst containing translucent fluid. It could be freed of its attachments without difficulty except in the region of the femoral ring, where it extended beneath Poupart's ligament. To facilitate its removal at this point it was opened, and was seen to be lined with a glistening, translucent membrane and to contain clear, straw-colored fluid. The funnel-shaped extension of the sac lying beneath Poupart's ligament was explored with a curved clamp, and was found to lead through the femoral canal into the abdominal cavity, as was proved by the withdrawal of a portion of omentum through the canal. There was no evidence of fibrinous exudate in that portion of the sac which could be pulled through the ring, and no evidence of old or fresh inflammatory reaction. The sac was ligated high and the femoral ring was closed by the Bassini technic. Convalescence was without incident, and the patient was discharged on the thirteenth day post-operative.

CASE II—A colored woman, aged forty-three years, was admitted to the hospital July 31, 1931, complaining of a tumor in the left groin. Four years prior to admission a mass the size of a hen's egg had suddenly appeared in the right groin. It was associated with no symptoms, and six weeks later it had disappeared overnight, quite as suddenly as it had appeared. A year later a similar mass, though considerably smaller, had appeared in the left groin and had grown slowly but steadily ever since. The slight pain which had at first been associated had promptly disappeared and there had been no recurrence, nor had there been any other symptoms of any sort except an unexplained loss of fourteen pounds in weight within the two years preceding application for treatment. The patient was a secundipara, her younger child being twenty-nine years of age, and the menopause had occurred ten years before. Otherwise her history was entirely irrelevant.

Physical examination was essentially negative except for a soft, freely movable, fluctuant tumor, oval in shape and about the size of a hen's egg, located in the femoral triangle and apparently attached to the deeper structures only in the region of the femoral ring. A diagnosis of femoral hydrocele was made on the basis of the previous case.

Operation was done August 3, under ether anæsthesia. A slightly curved transverse incision was made across the femoral triangle below Poupart's ligament, and a cystic mass with a very thin wall, which was promptly recognized as a femoral hydrocele, was dissected free from the surrounding structures without difficulty, except, as in the first case, in the region of the femoral ring. The sac was opened, and again as in the other case was found to be lined with a glistening, translucent membrane, to contain straw-colored fluid, and to show no evidence of old or recent inflammation. Exploration through the femoral canal revealed a direct communication with the abdominal cavity. The sac was ligated high and the femoral ring was obliterated by the Bassini technic. Convalescence was uneventful and the patient was discharged on the fifteenth day post-operative.

The single case found in the literature is herewith added.

BAILEY, H. Hydrocele of hernial sac. *Brit J Surg*, vol 15, p 166, July, 1927.

For fourteen years L. M., aged fifty-eight, had a right femoral hernia. About a year before she came under this author's observation she developed ascites, due to cardiac failure, and the hernial sac became distended with ascitic fluid. After months of treatment with digitalis the general ascites completely abated, but the fluid in the femoral sac persisted. One week before admission to the hospital the swelling had been tapped. The distended femoral sac was surmounted by a scab which had formed around the site of this puncture, and the contents had become slightly infected. Three days later the sac, which had by this time become frankly purulent, was incised. After discharging for a fortnight, the wound healed, and the patient left the hospital with no sign of the femoral hydrocele.

Comment—Bailey's case, it will be noted, differs in several respects from the personal cases reported, in which the hydrocele was apparently primary and not secondary to some other condition. It is well known that fluid in varying amounts is likely to appear in hernial sacs in the presence of incarceration, strangulation, or certain intraperitoneal diseases, such as tuberculosis, and Seward Erdman mentions that in femoral herniæ which contain tabs of omentum fluid may accumulate and may produce a condition simulating hydrocele. Bailey's case was undoubtedly a hydrocele at the time it was aspirated, but there is every reason to believe that it had begun as an ordinary hernia and had been converted into a hydrocele when the ascites developed as the result of cardiac failure. The hydrocele, therefore, was secondary to the constitutional disease.

FEMORAL HYDROCELE

The two cases from Charity Hospital are in every essential identical. While it must be admitted that negro patients of the type handled in this institution frequently give histories that are not entirely reliable, it can be taken for granted, I think, that these stories are essentially correct, and that trauma, ascites, pregnancy, previous disease, and other causes of increased intra-abdominal pressure can be eliminated as causative factors. Such inspection as was possible at operation revealed no gross evidence of pathology within the abdomen or within the sacs themselves, although unfortunately the latter point was not confirmed by histological examination. Neither mass was painful at the time of observation, and the second patient, who told a story of pain at the onset, stated that the discomfort disappeared promptly, and that at no time was it severe or disabling. In each instance the hernia was slow-growing, it was constantly present in all positions, and there were no sudden changes in size. There is no evidence in either case that the sac ever contained anything but fluid.

A rather interesting feature of the second case is the right-sided mass which was present for a few weeks a year before the left-sided tumor appeared. It is well known that peritoneal diverticula are frequently bilateral, and it is a reasonable assumption that the first tumor represented this type of hernia and that it disappeared spontaneously. It is unfortunate that the patient was vague in her recollection of its consistency.

The etiology of femoral hydrocele is impossible to establish from the facts at hand. Peritoneal diverticula are not uncommon in the femoral canal, but whether they are congenital or acquired is still to be proved. Strong evidence has been adduced on both sides of the question, but the arguments of the leading proponents of both doctrines are more notable for controversial fervor than for logic and exhibit on occasion a fine disregard for the elementary facts of physics and embryology. At any rate, the facts which have been established make it reasonable to assume that hydrocele begins as a simple hernia, a preformed diverticulum of the peritoneum, and that fluid, for some reason, accumulates and is retained within it. The fluid, rather than the hernia, needs explanation, and no explanation is entirely satisfactory.

Under ordinary conditions the fluid which is secreted by the wall of the sac and the secretion of the peritoneum which finds its way into the pouch, as in the gravity hydrocele of childhood, must flow readily back into the abdominal cavity when the recumbent position is assumed, for the neck of the sac, though narrow, is much shorter than the passage in the gravity hydrocele in the tunica vaginalis of childhood. It is necessary, then, to assume some occlusion of the neck of the sac to explain why the normal secretion of the peritoneal cavity and of the sac wall accumulated faster than it could be absorbed. In each case the opening was amply large to permit the return of the fluid to the abdomen, for it admitted without resistance the curved clamp inserted for purposes of exploration. There was no gross evidence of abdominal disease, therefore closure by an inflammatory exudate cannot be considered. Perhaps omentum or bowel occluded the opening, or

the two serous surfaces in contact with each other fused without the intervention of a fibinous exudate, as may occur in the hemiæ of childhood, the adhesions being so tenuous that they separated readily on the slight traction made when the sac was pulled down at operation. That is the most obvious explanation of the retention of the fluid within the sac, though it is far from satisfactory.

Furthermore, even assuming the occlusion of the neck of the sac, there is still to be explained the failure of balance of excretion and absorption, which is usually admirably maintained in closed serous cavities. Trauma is the most convenient explanation, and it must be granted that a tumor in the groin of an active woman is necessarily subjected to repeated minor insults, but again the explanation is inadequate. Gross evidence of hemorrhage and of inflammatory exudate, such as trauma would be certain to produce, was notably absent in both instances, and it seems highly improbable, also, that a femoral sac is ever subject to such frequent traumatism as is the tunica vaginalis in the male, in whom hydrocele of traumatic origin is a very rare condition. The etiology of femoral hydrocele, therefore, must be set down as a still unsolved problem.

THE GERMICIDAL EFFECTS OF TANNIC ACID
WITH AND WITHOUT THE ADDITION OF MERCURIAL ANTISEPTICS
BY JOHN D. MARTIN, JR., M.D., AND C. D. FOWLER, M.D.
OF ATLANTA, GA.

FROM THE DEPARTMENT OF SURGERY OF EMORY UNIVERSITY

DURING recent years the tannic-acid method of treating burns has been well established. Many modifications have been made, particularly with reference to the addition of germicidal agents to the acid. This change was made because of the differences of opinions regarding the germicidal action of the acid. There is, however, a certain element of doubt as to the bactericidal action of tannic acid with and without other agents. The literature is lacking in evidence on either side of the question. The purpose of this investigation is to compare the germicidal action of different strengths of tannic acid, first without and then with the addition of mercurial antiseptics.

The bacteria used were of the common varieties, *Staphylococcus albus*, *Staphylococcus citreus*, *B. typhosus*, *B. coli*, *B. pyocyaneus*, *Streptococcus viridans*, and a short chain streptococcus. Chemically pure tannic acid of strengths 1, 2, 5, 10 and 20 per cent in water was used. The solutions were prepared under aseptic conditions. The tannic acid itself was not sterilized because heat and chemicals which could be used in sterilization would cause changes of the acid. The culture media used throughout the experiment was prepared as follows: twenty-five grams plain agar, fifteen grams peptone, five grams sodium chloride, and three grams beef bouillon dissolved in 1,000 cubic centimetres distilled water. The whole was boiled until the constituents melted and then made neutral with sodium hydroxide, using phenolphthalein as an indicator. The agar was then sterilized twenty minutes in the autoclave. Five cubic centimetres of the agar were placed in each petri dish. All incubation was at 37.2° C. which is the optimum temperature for growth of the above organisms. In each instance where the tannic acid was used to cover the colonies, two cubic centimetres of the strength specified were used. Control plates were kept in each part of the experiment to be certain that the bacteria did not die of some other cause.

In order to determine if there was any gross chemical reaction between the mercurials and the tannic acid, metaphen 1:5,000, merthiolate 1:10,000, and bichloride of mercury 1:10,000 were placed with the different concentrations of tannic acid, 2, 5, 10 and 20 per cent. Two cubic centimetres of the mercurial were added to five cubic centimetres of the tannic-acid solutions. The merthiolate and bichloride of mercury showed no gross change when added to the tannic acid. The metaphen and tannic acid reacted with an effervescence which occurred at once in every instance, and after the solution remained for twenty-four hours the color had changed from a light brown to a dark green or brown. Due to the chemical reaction between the metaphen and the tannic acid, metaphen was not included in this work.

In the first part of the experiment the bacteria listed above were incubated for forty-eight hours. They were then checked by smear and colony formation, and in addition the colon and typhoid bacilli were checked on sugars and indol media. Two cubic centimetres of pure tannic acid of strengths indicated (Table I) were placed on the plates. The tannic acid was allowed to remain on for twenty-four hours and transplants were then made onto fresh plates which were incubated for forty-eight hours. Again

the bacteria were checked by the method just given. The bacterial growth was luxuriant in each instance with the tannic acid of strengths 1, 2 and 5 per cent. The bacterial growth was prohibited by 10 and 20 per cent solutions.

TABLE I

% Tannic Acid	1%	2%	5%	10%	20%	Control
<i>Staphylococcus albus</i>	Staphylococcus	Staphylococcus	Staphylococcus bacillus	—	—	+
<i>Staphylococcus citreus</i>	Spore bacillus	Staphylococcus	Spore bacillus	—	—	+
<i>B. Typhosus</i>	Short bacillus	Short bacillus	Short bacillus	—	—	+
<i>B. Coli</i>	Short bacillus	Spore bacillus Strep-bacillus	Short bacillus		—	+
<i>Streptococcus viridans</i>	Large bacillus spore bacillus	Bacillus	Streptococcus	—	—	+
Streptococcus short chain	Streptococcus short chain	Streptococcus short chain	Streptococcus short chain	—	—	+
<i>B. Pyocyaneus</i>	Bacillus	Staphylococcus	—	—	—	+

Bacteria incubated for forty-eight hours, two cubic centimeters of aqueous solution of tannic acid of strength specified placed on each dish, and then incubated for twenty-four hours. Transplants to new dishes made and read at the end of forty-eight hours' incubation.

The above procedure was repeated, using bichloride of mercury 1 10,000 instead of distilled water to make the tannic-acid solutions. There was no growth on the end plates (Table II).

TABLE II

% Tannic Acid	1%	2%	5%	10%	20%	Control
<i>Staphylococcus albus</i>	—	—	—	—	—	+
<i>Staphylococcus citreus</i>	—	—	—	—	—	+
<i>B. Typhosus</i>	—	—	—	—	—	+
<i>B. Coli</i>	—	—	—	—	—	+
<i>Streptococcus viridans</i>	—	—	—	—	—	+
Streptococcus short chain	—	—	—	—	—	+
<i>B. Pyocyaneus</i>	—	—	—	—	—	+

Bacteria incubated for forty-eight hours, two cubic centimeters tannic acid of strength specified in a solution of 1 10,000 bichloride of mercury placed on each dish, and then incubated twenty-four hours. Transplants to new dishes made and read at end of forty-eight hours.

The same procedure was repeated using merthiolate 1 10,000 instead of distilled water to make the tannic-acid solutions. There was no growth on the end plates (Table III).

GERMICIDAL EFFECTS OF TANNIC ACID

TABLE III

% Tannic Acid	1%	2%	5%	10%	20%	Control
<i>Staphylococcus albus</i>	—	—	—	—	—	+
<i>Staphylococcus citreus</i>	—	—	—	—	—	+
<i>B Typhosus</i>	—	—	—	—	—	+
<i>B Coli</i>	—	—	—	—	—	+
<i>Streptococcus viridans</i>	—	—	—	—	—	+
Streptococcus short chain	—	—	—	—	—	+
<i>B Pyocyaneus</i>	—	—	—	—	—	+

Bacteria incubated for forty-eight hours, two cubic centimeters tannic acid of strength specified in a solution of 1 10,000 merthiolate placed on each dish, and then incubated for twenty-four hours Transplants to new dishes made and read at end of forty-eight hours

It is of interest to note that in the above work the culture media was precipitated (tanned) more by the 2 per cent tannic acid than by the others Precipitation occurred in the following order 2 per cent four plus, 1 per cent three plus, 5 per cent two plus, 10 and 20 per cent one plus The 10 and 20 per cent changed the media to a pale brown and the 2 per cent produced a jet-black color

Discussion—It is well in dealing with any substance as a therapeutic agent that the properties and mode of action of such an agent be well understood before an interpretation of the results is made Tannic acid is an amorphous solid which is readily soluble in water and alcohol, but is practically insoluble in ether It yields precipitates with alkaloids, gelatin, albumen and proteins,¹ and also precipitates with heavy metals The coagulation of tissues occurs by converting the gelatines, albumen and proteins into insoluble compounds² Solis-Cohen and Githens³ state that the bactericidal power of tannic acid varies with the ability of the cell membrane of the bacteria to resist penetration One-half per cent tannic acid will kill *B coli* and *Staphylococcus aureus* in two hours but 10 per cent will not kill anthrax in twenty-four hours

In the first part of the experiment (Table I), unsterile tannic acid was used and the solutions were prepared under aseptic conditions It was found that the tannic acid of strengths 1 to 5 per cent are not sufficient germicides as evidenced by the recovery of the bacteria from the end plates in each instance The 10 and 20 per cent solutions were found to be germicidal within twenty-four hours This was further borne out by other work done in the same manner

It was also found that the tannic acid itself may be the agent of conveyance of the bacteria, as evidenced by the recovery of a number of bacteria other than the original The 1, 2 and 5 per cent solutions had eight contaminations, as follows Gram-positive spore bacillus, four, Gram-positive bacillus, three,

Gram-positive streptobacillus, one, Gram-positive staphylococcus, one. The 10 and 20 per cent solutions (Tables II and III), showed no growth on the end plates. Due to this fact, the only explanation of the large number of growths in the first part of the experiment is that the tannic acid itself carried the bacteria into the plates.

In the second and third parts of the experiment the mercurials destroyed the bacteria within twenty-four hours (Tables II and III). It was not deemed necessary to find how much less than twenty-four hours would be required to destroy the bacteria, because in the treatment of burns the solutions are allowed to remain in contact with the denuded areas for much longer periods.

Since there are no germicidal effects of the usual strengths of tannic acid (2 and 5 per cent) used in treating burns, and the solutions of 10 and 20 per cent are bactericidal, it would seem logical to use the latter. According to Seeger,⁷ the more concentrated solutions of tannic acid, even the lowest used, are highly astringent and tend to cause swelling and oedema of the tissues and too rapid fixation of the tannin. This factor alone would prohibit the use of more concentrated solutions in order to derive its beneficial bactericidal property. Therefore, the less harmful antiseptic solutions may be of some benefit, since it was found that in the less concentrated solutions of tannic acid with the antiseptics there was an inhibition of bacterial growth.

CONCLUSIONS — (1) One, 2, and 5 per cent solutions of tannic acid had no germicidal effect on *B. coli*, *B. pyocyaneus*, *B. typhosus*, *Staphylococcus albus*, *Staphylococcus citreus*, *Streptococcus viridans*, and a short chain streptococcus.

(2) Ten and 20 per cent tannic acid completely destroyed the above bacteria within twenty-four hours.

(3) The tannic acid itself may be an agent for carrying the bacteria into the solutions.

(4) A greater change of culture media was caused by the 2 per cent solution in that a more uniform change of color and precipitation of the proteins in the media was obtained.

(5) With the addition of 1:10,000 bichloride of mercury, or 1:10,000 merthiolate, to the tannic acid, all organisms were killed within twenty-four hours.

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THE TREATMENT OF VARICOSE ULCERS AND VEINS

BY GRANT P. PENNOYER, M.D.

OF NEW YORK, N. Y.

VARICOSE ulcers and other late results of varicose veins of the lower extremity cause prolonged, severe pain and disability, and frequently do not receive the attention which they deserve from the medical profession. Patients with much less disabling lesions of the head, chest or abdomen receive the most careful study by the senior members of the hospital staff, while the unfortunate, who has suffered for years with a chronic ulcer of his leg, is sent to the out-patient department. Here the extensive dressing required is sometimes regarded as a nuisance, and the case is assigned to a nurse or clinical assistant to apply an ointment and supporting bandage, while the doctor spends his time considering lesions more dramatic but much less important. The patients become discouraged with the inefficiency of the treatment, and often apply bandages and local applications as best they can for themselves. The result is that chronic leg ulcers are much more numerous than is our general impression. Those who are under treatment are patients in our hospital dispensaries where they do not usually see the members of this society. They frequently have visited their local doctors, but have either failed to receive relief or have been unable to meet the expense of prolonged treatment. The long, tedious series of dressings may even make the small clinic fees an economic luxury for them. The extreme gratitude of these patients for a cure, and the way they bring in their similarly afflicted friends are a source of real satisfaction to the doctor who works with them.

The indolent leg ulcer is always a result of some underlying pathology, and it is the proper recognition and treatment of this which is requisite for success. The ulcer is merely a symptom and sign of the real disease like the glycosuria of diabetes or the cough of tuberculosis. Success in healing does not depend upon the virtues of some local application, but upon the understanding and control of the underlying circulatory difficulty. These patients suffer infinitely more and longer than many for whom we advise major operations. The doctors in the out-patient departments should carefully study each case. An ulcer which fails to heal after a reasonable time under dispensary treatment should receive the attention of the experienced surgeon, and not be allowed to become discouraged and drift away.

The ulcers to which I refer have as their basis mechanical difficulties in the venous and lymphatic circulation. I am not discussing those originating from syphilis, diabetes, *etc.*, but the underlying causes of the ulcer may be multiple. A so-called diabetic or syphilitic ulcer may be greatly benefited by the elimination of some varicose veins which are aggravating it.

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A review of the normal physiology of the venous return from the lower extremities is helpful in understanding the pathology in these cases. In the erect position, the propulsive action of the heart-beat and the arterial pressure have almost nothing to do with the venous circulation in the lower extremity. The enormous area of the capillary bed compared to that of the arterial slows the blood-current in the capillaries down to the point where there is scarcely any pressure behind it. Kiogh¹ points out that a single capillary may have a larger cross-section than the tiny arteriole which supplies a large group. Also, each time an artery divides, the cross-section of its branches is greater than that of the original trunk. This results in a rapid fall of blood-pressure as we reach the terminal arteriole. The normal capillary pressure is only four to five centimetres of water at the level of the heart, a pressure insignificant when compared with the pressure required to lift the venous blood from the lower leg back to the heart when we are in the erect position. The well-known pumping action of the muscles as they press on the veins, which are equipped with valves to prevent back flow, is the propulsive force behind the venous return from the dependent extremities. The vein, with its frequent valves, is really a series of chambers, each one of which as it is compressed by the muscles empties into the one above. The normal muscular activity, being as it is alternate contraction and relaxation, is ideal for this pumping action in the veins. It is evident why we have such discomfort when we are compelled to stand still for long. Our constant shifting positions from one foot to the other, *etc*, as we attempt it, are really reflexes to stimulate the venous circulation. Even when we deliberately dangle our legs, relaxed as much as we voluntarily can, the venous blood-pressure in the foot is far below the theoretical hydrostatic pressure which would result from its distance below the heart. The muscle tone, which is really rapid rhythmic contractions, is keeping this venous pump at work. Stand still, and the dorsal veins of the feet distend, exercise the leg muscles, and they collapse. During vigorous activity, the blood-pressure in the normal foot veins approaches zero, due to the rapid removal of blood from them by this pumping action of the muscles. Anything which cripples this venous pump, such as incompetence of the venous valves, immobilization, injury to the muscles, *etc*, cripples the venous return from the extremity, unless the extremity is elevated approximately to the level of the heart.

The superficial veins are deprived of this muscular support. They are provided with numerous communicating veins with their valves so placed that blood can flow from the superficial to the deep veins. As soon as the venous pressure in the saphenous veins rises above that in the deep veins, blood can flow freely into the deep system where the muscular activity pumps it upward. This provides a sort of safety valve against excessive pressure in the saphenous systems as long as the valves are competent. The pressure in the normal saphenous vein is much less than the hydrostatic pressure which would result from its distance below the heart and which one would expect to be required to keep the blood flowing upward.

Other factors in the venous circulation are the varying negative pressure in the thorax during respiration and the positive pressure in the abdomen. The effect of normal respiration on the venous return of the lower extremity while standing is insignificant, as evidenced by study of the venous pressure during respiration. Increased abdominal pressure is necessarily transmitted to the abdominal veins and the lower extremity veins as they enter the abdomen.² The extraordinary height to which this abdominal pressure can rise during violent effort has recently been measured by Murphy and Mengert.³ The abdominal veins have no valves, and this pressure can not only pump the blood on into the thorax, but also force it back against the valves in the veins of the thigh. During violent abdominal straining, our thigh muscles are also in strong contraction, which protects the deep veins but the saphenous system valves are subjected to the full pressure. The normal saphenous valves have been shown to give way at pressures of about 180 millimetres of mercury, which is not unusually high for the abdominal pressure during violent muscular work.⁸ Add to this pressure the constant strain of the hydrostatic pressure, and it is evident why varicose veins are so numerous. As the upper valves give way, more pressure is transmitted to those remaining below. As the succeeding valves give way, the whole superficial system of veins becomes wide-open channels with nothing to hinder the free regurgitation of blood downward. I do not say this mechanical back pressure is the only explanation of varicose veins but it is certainly present in every case of the common surface varices. Congenital and familial weakness of the veins certainly plays a part, and perhaps many other factors which we do not recognize and cannot control.

The source of all the difficulties resulting from simple surface varicose veins is this free downward regurgitation of venous blood towards the periphery, and the resulting capillary stagnation under pressure. The measured venous pressure in varices approaches the theoretical hydrostatic pressure which would result from the position of the vein in relation to the heart. This is still further increased by abdominal straining. This pressure is of necessity transmitted to the capillaries, as otherwise the blood current would be completely reversed in the capillaries. The blood in these veins is by analysis much higher than normal venous blood in carbon dioxide and non-protein-nitrogen content, and much lower in oxygen.⁴ The capillary permeability has been shown to be very sensitive to just these conditions, increased pressure, increase of carbon dioxide and lack of oxygen.^{5, 6} The effect of this is a profound change in the nutrition of the subcutaneous tissue. As the deep veins are intact, the disease is entirely confined to the subcutaneous tissue, which is a constant and striking clinical fact even in the most advanced stages of œdema and ulceration.

The condition of the valves in the veins communicating between the deep and superficial systems is important. When these are competent, these perforating veins are constantly removing the blood from the surface veins, and the varices, being rapidly emptied, and the pressure in them thereby kept low,

may do no more harm than greatly add to the burden of the deep veins. This is the situation when we find large varices without clinical symptoms. The extra burden on the deep circulation is undesirable, and the patient usually has fatigue and weight sensations which he does not connect with his veins, or which he has had so long that he accepts them as natural. If the communicating veins do not have competent valves, they cannot so effectively decompress the surface varices. Furthermore, blood part way up the deep veins can escape into the superficial group, where it again falls back towards the foot to reenter the deep veins, thus completing a vicious cycle.⁷ If the varices are extensive, the volume of this regurgitated blood may be more than the total volume of blood returned to the heart to receive oxygen and nutrition. This vicious cycle of old blood has been demonstrated under the fluoroscope by lipiodol injections. This situation results in nutritional changes of the entire subcutaneous tissue out of proportion to the size of visible varices.

The pathology which results from this venous back pressure on the capillary circulation is very extensive. An early and almost constant clinical sign is the common pigmentation which results from the increased capillary permeability and diapedesis of red blood-cells. I consider this pigmentation as diagnostic of impaired nutrition from varicose veins, even when they are not visible. When ulceration has occurred, the element of infection and cellulitis becomes important. These ulcers are always surrounded by a zone of acute inflammation, and frequently there are exacerbations of this infection element when large areas of the leg become very hard, swollen and painful. It is the addition to the already existing venous stasis of the element of repeated and chronic infection which results in the lymphatic blockage and elephantiasis aspect of these cases. There is a local obstruction of the lymphatics in areas of cellulitis and infection. Subcutaneous injections of India ink, which is normally rapidly removed by the lymphatic circulation, remain relatively fixed *in situ* when injected into areas of acute inflammation.⁹ This has recently been shown by Kuhns¹⁰ to be true also in joints. The absorption of substances injected into joints, which are normally quickly removed by the lymphatics, is greatly delayed if the joint is acutely inflamed before the injection.

This lymphatic obstruction within the tissues, resulting from the prolonged chronic and repeated infection in the ulcer cases, added to the existing venous difficulties, gives all the necessary elements for the gradual formation of a true elephantiasis, as described by Matas,¹¹ *i e*, venous and lymphatic obstruction with repeated attacks of non-pus-forming cellulitis. Halsted,¹² in studying the arm cases following breast amputations, made the same observations. Homans¹³ has always emphasized the lymphatic element in these cases. The progressive fibrosis of the subcutaneous tissue still further destroys the lymphatic circulation, and finally the whole subcutaneous tissue and skin of the leg is deprived of lymphatic as well as the normal venous drainage.

The above conditions are the late results of simple surface varicose veins,

but there is also a group of cases where the deep veins have been damaged by a previous severe deep phlebitis or phlegmasia alba dolens. The late difficulty of the deep veins in these cases is usually not a diminution of the capacity of the veins as commonly supposed, but incompetence of the valves. These valves are just as important in maintaining the circulation of the extremities as the heart valves themselves. As soon as they are crippled, either mechanically or by infection, there is nothing to prevent the backward flow of blood in the dependent leg until the venous pressure is high enough to lift the whole column of blood up to the heart, a pressure way above the normal working pressure of the capillaries. These cases have the same difficulties as the simple surface varices, *i e*, œdema, ulceration, chronic infection, elephantiasis, *etc*, but the disease is not confined to the subcutaneous tissue. Some of these cases have large surface varices, which are sometimes thought to be compensatory dilation. I believe that they are usually not compensatory but true varices which are the result of the high venous pressure. If they have a positive Tiendelenburg, it is safe enough to obliterate them, but the patient receives little benefit. As a group, these cases are most discouraging to treat, as it is impossible to restore the deep venous circulation. Most of the failures of the Kondoleon¹⁷ operation for elephantiasis, which is an attempt to give the superficial tissues lymphatic and venous drainage by anastomosis with an intact deep circulation, are undoubtedly cases which fall into this class. The excision of ulcers and placing skin grafts on the deep tissues is also doomed to failure without an intact deep circulation, as well as the obliteration of the surface varices. Pressure by bandages, *etc*, is usually of little help. Reduction of the capillary pressure and restoring the venous circulation by elevation is the only way to heal the ulcers in this group. These cases are usually easy to recognize by their characteristic history of severe œdema which involves the superficial and deep tissues dating directly from the attack of milk leg.

With these points in mind, it is much easier to develop a rational therapy for the ulcer cases. If the patient has large surface varices, and has not progressed to the stage of lymphatic block, chronic brawny œdema, and elephantiasis, remarkably rapid and permanent cure can be obtained by sclerosing the offending veins by chemical means. The ulcer in these cases usually has obvious and intimate contact with the varices. There is little or no œdema. Large veins lie just above the ulceration and very frequently under it, in which it is easy to demonstrate a positive Tiendelenburg sign. The majority of the cases fall into this group. The chemical sclerosis of the offending veins by injecting them will often immediately relieve the patient of all pain and initiate healing in the ulcer. We have in our series an old lady of eighty who had had an ulcer of this type unhealed for forty years, which healed in a month after obliteration of a few veins. The larger the veins, and the more obvious their relation to the ulcer, the more satisfactory is the result of this treatment. The local application to the ulcer is immaterial.

If the ulcer patient has progressed to the point of hard, brawny œdema

on early elephantiasis, the problem is much more difficult. The varicose veins are frequently lost in the dense subcutaneous tissue. They often have no obvious relation to the ulcer, and the pathology may seem to be out of all proportion to the size of the veins. These patients are often fat, and it is frequently impossible to do a Trendelenburg test. The whole subcutaneous tissue has lost its normal venous and lymphatic drainage. Obliteration of the varicose veins in these cases should be done but it is sometimes of little benefit. If it fails, these cases with large chronic or repeatedly recurrent ulcers should be admitted to the hospital and operated upon according to the method of Homans¹⁴. The results are very satisfactory in the twelve cases we have done. I have already shown three of them before this society. The ulcer is excised along with the underlying deep fascia and scar tissue, and Thiersch grafts are laid right on the deep tissues, whether it is periosteum, tendon or muscle. Thiersch grafts are used as the large areas involved can be covered more quickly by this method, and the results are good. The grafted area receives a new source of lymph and venous drainage from the deep circulation^{20, 21}. The hard brawny edema disappears from this area, and the new skin, now properly nourished, is soft and normal. The principle is similar to that of the Kondoleon¹⁷ operation for elephantiasis, in which large areas of the deep fascia are excised to allow free anastomosis between the deep and subcutaneous circulation. If ulcers recur, they occur on the edge of the grafted area, or in an entirely new area, where the deep fascia is still *in situ*.

Unsuitable for this treatment is the occasional case with damaged deep veins from a severe phlebitis. It is sometimes difficult to be certain that the case falls into this group, as many of the post-phlebitis cases respond well to treatment. Extensive edema of all the tissues, superficial and deep, is the early and ever predominant feature of these discouraging cases. DeTakats⁴ has demonstrated how the X-ray is valuable in determining if the disease is confined to the subcutaneous tissue. In a properly exposed plate, the layers of the soft parts can be made out especially when the subcutaneous tissue is very much thickened.

Trout¹⁶ published a series of cases successfully operated upon essentially according to the method of Homans, but added a point to the technic. He excised a strip of fascia above the ulcer. This combines the Kondoleon operation with Homans'¹⁹ excision of the ulcer. This involves raising flaps of skin, which in the poorly nourished diseased tissue is precarious. The only case I tried this on recently sloughed a large area of one flap.

As to technic, I believe that the skeptics of the injection treatment for varicose veins have either not tried the treatment or are unable to overcome the doctor's innate fear of intravenous medication, embolism, *etc*. Homans, long a skeptic, now acknowledges it is an excellent way to heal ulcers but believes the injected veins all recanalize. This is not true in our experience. Our series now numbers over a thousand cases, about a hundred of which I have been able to follow over three years. I admit that some veins do

recanalize The exact percentage is difficult to state, as it is often hard to be sure whether a vein is really the old vein or a new one Many of the cases do, in time, form new varices The treatment does not pretend to rid the patient of the fundamental causes for his veins, which are naturally always present, but simply to destroy the veins present at the time We have many cases in the clinic who have been previously operated upon by distinguished surgeons who have developed large new varices, frequently right in the scars, where all the veins have been removed Veins, on the laboratory shelf, hardened in formalin did not recanalize This tendency to form new veins can be diminished by paying particular attention to the trunks in the thighs I can see no necessity for ligating them, as they can be easily chemically obliterated The internal saphenous vein may be varicose, *i e*, its valves be incompetent, and yet not be visibly dilated or tortuous To make it still more difficult, it frequently cannot be palpated in the thigh fat In these cases it can usually be found by the impulse of a fluid wave transmitted from a percussion tap on the vein below the knee, where it is dilated and tortuous Often there are several trunks in the thigh besides the internal saphenous If the recurrence of new veins in the leg is rapid, one should strongly suspect he has missed one or more varices in the thighs, the back pressure from which is stretching out the leg veins The occasional recanalizing of a treated vein and the usual tendency in time to form new veins is not a serious objection to the injection treatment It is such a simple matter to give one or two more injections as it proves necessary A simple treatment given to an ambulatory patient is such a contrast to repeating the old operative procedure The recurrences, taken in time, are usually much smaller than the original veins I always explain to my patient that I am unable to eradicate the fundamental causes of his varicose veins, and am simply removing the veins which he has at the present time

Recanalizing of injected veins can be largely prevented by good technic It is perfectly true that the characteristic hard thrombophlebitis which follows the injection does not necessarily mean a permanent sclerosis Too weak injection fluid, excessive dilution by blood in a large vein, too rapid circulation in the vein may cause a chemical phlebitis of insufficient severity to destroy the vein permanently

Another limitation of the treatment is the occasional occurrence of ulcers The solutions are all caustic The essence of the treatment is a chemical destruction of the intima of the vein, and a drug with sufficient irritating power to do it will destroy the poorly nourished subcutaneous tissue of these cases, statements of drug manufacturers notwithstanding I have seen these sluggish chemical burns occur after all the commonly used solutions If the leakage has been slight and rather deep, the actual necrosis of the skin may be delayed for several weeks, the area meanwhile looking like a localized chronic infection If the leakage has been extensive, the sloughing will be very prompt, and discouragingly slow to heal With good technic, this accident should be rare, certainly not in over 2 per cent of cases I always

explain this possibility and probability to intelligent patients to protect the treatment and myself from unjust criticism. Minor points in technic diminish the possibility of slough in addition to skill in venous punctures. A very easily sliding syringe and not too small a needle help, so when the needle is properly placed, the reflux of blood into the syringe is very free and the injection can be made almost without resistance. Also, if there is the slightest doubt as to the position of the needle, or if it has slipped in and out of the vein repeatedly, one should be very quick to acknowledge failure, and either try a new vein or abandon the treatment till a later date. I have never seen serious complications from these leakage sloughs.

We have had no emboli in our series. They have been reported in the literature, and can usually be traced to cases where the injections have been given in the presence of a preexisting phlebitis. Injections should never be given if there is any possibility of infection being already present in the veins, as the chemical irritation seems to aggravate it.

Our method of injecting veins is very simple. We have used sodium salicylate, quinine and sodium morrhuate solutions. For extensive and permanent sclerosis, I believe that sodium salicylate is the best, but the severe cramp which follows its injection frightens many patients away to clinics who are using the other two solutions, the injection of which is painless. For the ordinary varices of the lower leg, I have the patient sit on an examining table with the leg in my lap as I sit in front of him. I do the lower veins first. As the blood-current is reversed, it is much easier to obtain good sclerosis in the thighs and larger veins above, if the smaller veins below are occluded first. It is easier to identify and inject all the lower leg veins if they are treated first. I do not use tourniquets unless the veins are very large or the injection is made in the upper thigh. In large sacculations, *etc.*, where there would be excessive dilution, I attempt to inject the vein collapsed and hold the solution in the treated segment by double tourniquets. This is easily accomplished by raising the extremity and applying the tourniquets after the needle is placed in the vein. If all the veins below are blocked, good sclerosis can be obtained even in the internal saphenous in the thigh by injecting with the patient standing. I have never seen a thrombosis of the deep femoral result from an injection. The blood-current in it is so much more rapid than in the varix that the sclerosing agent is too rapidly diluted and swept on to do any harm.

For the comfort of an ambulatory patient, I recommend only one injection be given at a time and not repeated until the acute inflammation of the previous injection has started to subside. This usually means three to seven days' intervals. Under this plan the patient can usually continue with all his regular activities throughout the treatment.

If the injected vein is large, it is a distinct help to keep the vein collapsed by a firm pressure bandage or stocking during the sclerosing process. The thrombus which forms and organizes in the vein is smaller, and the hard tender swelling is much less noticeable. I have done many without compres-

sion bandages, and it seems to me those who feel that they do not help in the large veins, have not applied them so as to keep the veins really collapsed.

The technic we have used in excision of ulcers is easy. The patient is kept in bed with the leg elevated until the œdema has been reduced as much as possible. This usually requires seven to ten days. If there is much purulent discharge and active infection, Dakin wet dressings may be used. The whole ulcer area is then excised, taking particular pains to remove all the underlying scar tissue and deep fascia. Success depends upon placing the grafts on healthy deep tissues. Any sort of graft probably could be used, but we have used Thiersch grafts as the large areas exposed can be covered rapidly this way, and the thigh from which they are taken heals rapidly without scar. The individual grafts are laid so they overlap each other and the edges of the wound, so they completely cover the raw area. They seem to take well right on periosteum, tendon and muscle. Even if take has not been 100 per cent, the region has a more normal venous and lymphatic circulation, and when it does heal, the skin will be pliable, soft and healthy. Perforated rubber tissue is placed right on the flesh graft and stuck around the edges of the wound with chloroform so it cannot shift. An even layer of gauze dressing is placed over this, and then a thick flat rubber sponge is strapped firmly over this whole area with wide adhesive tape. Further pressure is obtained by a firm circular bandage. This pressure is a very important point in getting the graft to take. The first dressing is done in five to seven days according to the odor. The patient is kept in bed with the leg elevated until the wound is healed and the grafts firm, which is usually about three weeks. When the patient first gets up, the grafts are apt to become very cyanotic, and their nutrition must be watched carefully the first few weeks in order not to lose them. Supporting pressure with sponges or absorbent cotton bandaged firmly over the area, and frequent periods of elevation help. As the new circulation establishes itself, the grafts become thicker, firmer and more like the normal skin.

To summarize, varicose ulcers, if they receive the study they warrant, can be made to heal. This can usually be accomplished by obliterating the varicose veins. In legs with chronic, brawny œdema and elephantiasis, where the lymphatic and venous circulations of the subcutaneous tissue are diseased beyond repair, permanent cures can be obtained by excising the ulcers, together with the underlying scar tissue and deep fascia, and placing skin grafts directly on the deep tissues. If the deep circulation is also diseased, this case is discouraging and elevation is the only cure.

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FRACTURES OF LOWER END OF HUMERUS

BY WILLIAM BATES, M D
OF PHILADELPHIA, PA

THEORETICALLY, all fractures should be promptly reduced. Certain fractures have been allowed to wait for one reason or another before reduction was attempted, and apparently no harm done. The fractures of lower end of the humerus, especially those involving the elbow-joint, I have always considered as emergencies calling for immediate attention. This stand is taken because reduction is easier to accomplish, and becomes progressively difficult by the hour. Secondly, the earlier reduction is accomplished, the easier it is maintained. Thirdly, in the absence of injury to major vessels, the œdema associated with fractures starts to subside as soon as complete reduction occurs. This being the case, it would seem that the dreaded Volkmann's contracture could be avoided by promptness. Lastly, early restoration of functions is more readily obtained when normal alignment was accomplished promptly.

The history of the accident producing fractures of the lower third of the humerus has many times been hard to obtain. All too frequently it appears to be a "fall on the outstretched hand," and yet when we consider the classical description of various fractures, this is given as the mechanics of anything which goes wrong with any part of an upper extremity from a fracture of a carpal bone to a dislocation of the shoulder. There is, therefore, some other factor present, and because of the rapidity with which the fracture is produced, the determining factor is elusive. In the absence of direct blow from a larger object, fractures of lower third of humerus are usually not associated with fractures elsewhere in the extremity. As multiplicity of fractures is usually due to continuation of the producing force after the initial factor, the elbow is probably in partial flexion when the patient falls on the outstretched hand. The comminution of the supracondylar region is then produced by the body weight acting as a new force of injury from above in contrast to the original impact below.

Following prompt reduction under anæsthesia and under fluoroscopical visualization whenever possible, the dressing is applied with the forearm in the same relationship to the arm as when reduction was accomplished. The loss of the carrying angle in most cases is probably due to dressing the forearm against the front of the chest. The writer is indebted to Doctor Eliason for this observation and thoroughly believes that better alignment of the fracture site is maintained. The degree of flexion of forearm is likewise governed by the relationship which existed when reduction occurred.

While never having favored the very acute (Jones) flexion, if it is neces-

* Read before the Philadelphia Academy of Surgery, January 8, 1934

sary to flex that much to get reduction then that much is necessary to maintain reduction. However, as experiences confirm the fact that with proper reduction, oedema immediately begins to subside, I have had less fear of this position. In the cases where its use was compulsory, there have been no contractures, so that my feeling is more and more in favor of rapidly preventing oedema to forestall contracture.

After the dressing is applied, the patient is held until the X-ray is developed. Believing in early reduction, I do not consider it logical to attempt reduction, dress, and wait until the next day to X-ray or see the film.

If the film is not satisfactory, the time to complete the reduction, I feel, is right then. The exceptions to this, of course, are in the types of cases where I am convinced that some form of traction is necessary to give the best result, and secondly where it is shown that open reduction is indicated.

In operating on these fractures, I have tried to convert the multiple fragments below into one group, and then consider the best way of dealing with the shaft above and the composite lower fragment. For future restoration of function, I believe the less hardware used the better the result. In one case where the capitellum was separated, I found it necessary to remove it, while in the others bone screws were used.

I have found traction necessary in very few cases but recently had a case where the usual deformity was reversed. Ordinarily, one expects to find the upper fragment anterior and the supracondylar fragments carried posteriorly. In this recent case the supracondylar region was shattered, converting the humeral articular surface of the elbow-joint into three fragments lying anterior to the shaft of the humerus which was protruding through the skin. Open reduction in this case revealed only shell fragments which were insufficient for fixation. The wound was drained, wrist fastened to upper arm by adhesive and wide traction applied to upper forearm in line with the upper fragment. Later X-ray showed excellent alignment, but on transferring to molded splints the internal condyle was pulled slightly up and out. The condition of patient did not warrant further interference as later developments proved.

If my own experience (to which I was limited when assigned this subject) has taught me anything, it is that fractures of the lower third of humerus are so varied that few thumb rules exist for their treatment, and that each one calls for individual consideration as to the type of dressing after early reduction, and that early motion is necessary. I have found much more help in occupational therapy than in the use of baking and massage. Frequently, both aids are necessary, but when the time for active motion arrives, patients progress more rapidly under occupational-therapy supervision.

FRACTURES OF THE LEG BELOW THE LOWER THIRD *

BY ADOLPH WALKLING, M D

OF PHILADELPHIA, PA

THE treatment of fractures of the lower third of the leg will ever be a subject where there are differences of opinion and it is well that this is so. Some of us are unwilling to treat all these fractures by the same method. Each fracture is a separate problem and should be studied and treated by that method which seems best to fit the individual case.

These fractures are extremely important as almost any deviation of the weight-bearing line produces disability which is sometimes sufficient to cause almost complete industrial incompetence of the individual, necessitating the use of a cane or crutches.

In no other series of fractures is accurate reduction and its maintenance so important. Any angulation of the tibial fragments will interfere with weight bearing. The weight bearing must, in order to be painless, be transmitted through smooth joint surfaces which makes essential accurate replacement of fragments involving the articular surface. It is sometimes permissible and occasionally unavoidable to have a fracture heal with some shortening. While this is undesirable the function of the leg is seldom interfered with. Perfect function is more apt to result after perfect alignment is secured early. Rotation of either fragment or lateral deviation can be prevented and must be absolutely avoided. When rigid dressings are used the foot and ankle should be kept in the position of optimum function, the foot at right angles, slightly inverted, and the arches supported.

The weakness of the muscular structure of the foot and leg makes it absolutely necessary that when weight bearing is allowed a certain amount of support be provided by elevation of the inner border of the heel or heel and sole. This support is all too often forgotten but is essential to quick return of function. Massage and movement is necessary to prevent atrophy of the muscle structure and should be insisted upon by all who treat these fractures. The period of disability is directly proportional, the earlier they are instituted the better the result.

X-rays—Ideally, there should be an X-ray made (1) before reduction, (2) after reduction and a permanent dressing has been applied, (3) as a follow-up. This is not always possible because occasionally an X-ray is not available beforehand because of location of the patient and for reasons of economy. Pictures should be taken as often as necessary to assure correct position of fragments during the process of healing.

Thorough skin cleansing with soap, water and alcohol and the application of a sterile dressing should be done in each fracture before a retention appara-

* Read before the Philadelphia Academy of Surgery, January 8, 1934

tus is applied Vesicles or abrasions may easily become infected and cause considerable anxiety as to the ultimate outcome

Simple Undisplaced Fractures—Often a plaster case can be applied immediately as there is never much swelling The case should always be split along the crest of the tibia The case need only extend to the knee It is our rule that the case extend to the knee in fractures involving the lower third and to include the knee if the fracture is higher If there is considerable swelling the leg is placed in a fracture box properly padded with a soft pillow and an ice bag placed over the site of fracture The box should be opened every day and gentle massage given The joints are moved and after the padding has been rearranged the box is closed After the swelling has subsided sufficiently a case is applied This is split before it hardens The case is a light one so that one may spring it open and remove the leg for massage and movement The massage and movement is given in the Out Patient Department by the attending surgeon Physiotherapy is occasionally used in the aged

In fractures of the fibula alone, weight bearing is allowed at the fourth week Complete return of function is usual in six weeks Weight bearing in fractures of the tibia alone is not allowed for five weeks in the transverse fractures and six to eight weeks in the oblique or spiral type There was complete return of function in an average of nine weeks in our series In undisplaced fractures of both bones weight bearing is begun gradually at five weeks Full weight bearing, walking with a cane, is usually permitted at six or seven weeks Patients returned to work with complete return of function in an average of twelve weeks In undisplaced fractures of the malleoli an adhesive plaster boot is applied The patient is given crutches for two weeks Shoe correction is strictly adhered to Good results are to be expected regardless of the method of fixation

Fractures with Displacement—Reduction should be accomplished immediately by the closed method under anæsthesia provided much manipulation is necessary The anæsthetic of choice is ether I have never used spinal anæsthesia and have used local anæsthesia on one occasion with satisfactory results when a general anæsthetic was contra-indicated An X-ray should always be made after reduction It is not always prudent to wait for an X-ray before reduction as in such fractures as the Pott's fracture the deformity is so typical that it is usually reduced correctly The fluoroscope is used for visual reduction when available It is still a matter of dispute whether every fracture should be reduced in this way There is no question that in the complicated fractures it is essential and in nearly all fractures highly desirable, but it is a question sometimes of availability

The preliminary X-ray is made not to tell us that a fracture is present, because the diagnosis of fracture, where there is displacement, is obvious It tells us the exact position of the fragments and gives us a very definite idea of the mode of production and therefore what manipulations will be necessary

for reduction. If the deformity and position of fragments are obvious the preliminary X-ray is not absolutely necessary.

Failure of Reduction—This demands either open operation or continuous traction, almost always skeletal in type. Surface traction with adhesive is next to impossible in the fracture about the ankle. Tenotomy of the Achilles tendon may be done to advantage but if skeletal traction is used it is not necessary. This should not be a complete transverse tenotomy but a partial transverse section at different levels because union takes place sooner and with more certainty.

Fixation—We have never applied a closed case to a recent fracture immediately after reduction. Teaching a method such as this to undergraduate students may be productive of a great deal of harm as all will not be accustomed to the use of plaster. The method has no particular dangers in the hands of one experienced in plaster work. Moulded plaster splints have been employed in certain special fractures with good results, for example, transverse fracture of both bones near the epiphyseal line. This so-called Stimson splint has much to recommend it. A method of fixation that has been most useful is the fracture box. Here we have rigid splints constituting the sides of the box padded with a soft pillow. The padding can be rearranged as often as desired. Extra padding of folded towels or lint may be inserted either before or after the box is closed. Daily inspection of the fracture is facilitated by merely opening the box. The fragments are not disturbed. Massage can be given daily. The leg is elevated if necessary by elevating the box. Marked swelling is allowed to subside somewhat with the aid of ice locally and massage. A split case is applied when advisable with the foot at right angles, slightly inverted and the arch supported.

In the writer's series the average length of time before application of the case was twelve days. The patients remained in the hospital from fourteen to sixteen days. This does not include cases that were kept in the hospital for prolonged periods because of other injuries. There were fifteen cases of the so-called Pott's type during the past three years which were completely followed up. These patients returned to work on an average of fifty-seven days. One case of non-union was not included. The longest period was seventy-six days and the shortest period was forty-six days. In all cases the inner side of the sole and heel was wedged one-quarter inch to begin with. This was reduced in about three months to one-eighth inch and in six months was removed. In one case the quarter-inch wedge was so comfortable that it still remained at the end of two years. The severely comminuted fractures should be treated with skeletal traction. The fracture box here fails to come up to expectations except occasionally. It sometimes is difficult to maintain anterior posterior alignment. The fracture with separation of the posterior articular lip of the tibia may be treated in a fracture box but often this does not correct the displacement of the small tibial fragment. Mechanical fixation is sometimes necessary in this type. The fragment must be replaced at all hazards as otherwise weight bearing will be seriously interfered with.

Compound Fractures—Most of the compound fractures of the leg occur in the lower third. If the fracture is compound from within it is only necessary to antisepticize the protruding fragment, if any, and it has been our practice to use tincture of iodine both on the leg and in the wound. A prophylactic dose of combined tetanus and gas bacillus antitoxin is given. Reduction is accomplished under anæsthesia, a sterile dressing is applied to the wound and a suitable retention apparatus applied to the leg. Immediate operative fixation of the fragments in compound fractures is rather a risky procedure. Fractures compound from without should, of course, have a thorough dé-bridement under suitable anæsthesia and a prophylactic dose of the combined serum. The number of gas bacillus infections has been greatly reduced since the prophylactic injection has been used. We have been allowing the wounds to remain open to be dakinized. The writer has not yet had the courage to use the Orr method of treatment. The Thomas splint with skeletal traction when necessary is used. Skeletal traction in any way desired is the best method of fixation, particularly if the fracture is badly comminuted or if there has been much loss of tissue. The fracture box has been used on occasion. When union has progressed sufficiently a split or a windowed case was applied.

SUMMARY—(1) The fracture box may still be used to advantage in the treatment of fractures in the lower third of the leg.

(2) The badly comminuted type and almost all compound fractures had best be treated by skeletal traction.

(3) The articular surface of the lower end of the tibia should be returned absolutely to normal if at all possible.

(4) The normal weight-bearing line must be preserved to insure the best results.

(5) Support of the foot by wedging the inner side of the sole and heel or the heel alone is almost essential. Only too often is this neglected. If done regularly in these fractures good results are assured.

FRACTURES OF THE SHAFT OF THE HUMERUS

BY CALVIN M. SMYTH, JR., M.D.

OF PHILADELPHIA, PA.

THE material for this paper has been drawn from sixty-nine consecutive cases of fracture of the shaft of the humerus of sufficient severity to warrant hospitalization. These 69 cases occurred in a series of 191 hospitalized fractures of the humerus, constituting 36.1 per cent of all fractures of the humerus admitted to our care over a period of three years. The sites of fracture were as follows: Upper third, 31, or 44.9 per cent; middle third, 24, or 34.7 per cent; lower third, 14, or 20.2 per cent. Twenty-six were transverse, 16 oblique, 7 spiral, 18 comminuted, 2 compound. No cases treated as out-patients have been considered inasmuch as cases so treated should, in the writer's opinion, be limited to those fractures without displacement of the fragments in which no reduction is required and in which the simple methods of immobilization suffice. In practically all fractures with displacement of the fragments ambulatory treatment is inadequate for the following reasons:

(1) In transverse fractures reduction is often easy but retention is often difficult or impossible by simple methods.

(2) In oblique and comminuted fractures suspension and traction or open operation, which offer the only hope of satisfactory functional and anatomical results, can be instituted only in a hospital.

TABLE I

Total fractures of humerus	191	
Fractures of shaft	69	36.1 per cent
Site of fracture		
Upper third	31	44.9
Middle third	24	34.7
Lower third	14	20.2

Methods of Treatment Employed—Regardless of the type of fracture or the definitive treatment finally instituted, all cases are temporarily immobilized in the Thomas or Murray-Jones arm splint. This should be done by the ambulance surgeon or by the man on duty in the receiving ward before the patient is moved about in any way either for X-ray examination, undressing or any other reason. Following the X-ray examination and an accurate estimation of the situation, the method of treatment best suited to the individual case is instituted. This will depend on such factors as the type and location of fracture, whether oblique, transverse or comminuted, and whether it involves the upper, middle or lower portions of the bone.

In our experience, transverse fractures, if seen early, can usually be reduced easily, but in spite of the greatest care are extremely difficult of

retention An illustrative case is that of a strong healthy woman of twenty-six years with a transverse fracture of the middle third The deformity was reduced easily under the fluoroscope and perfect position obtained She was dressed with coaptation splints, an internal right-angle splint and a shoulder cap The arm was fastened to the side with adhesive plaster and a swathe She was allowed to go home after the reduction and the deformity promptly recurred Open operation was finally done

In oblique fractures, provided there is no interposition of soft parts, satisfactory reduction can usually be accomplished by traction and suspension The type of traction employed depends largely upon the location of the fracture In lower third fractures, the arm is placed in abduction with the forearm in full extension in a Murray-Jones splint and skin traction applied to the arm and forearm Six to ten pounds' extension usually suffices In middle and upper third fractures the arm is abducted but the forearm flexed to a right angle, traction being made upon the arm alone In our experience skin traction in fractures of the humerus will accomplish all that skeletal traction will, and a deformity which will not yield to this method, will, in most instances, indicate interposition of soft parts and require open reduction Skeletal traction is not anything like as satisfactory in the upper as in the lower extremity where we employ it in almost every instance

TABLE II

Type of fracture	
Transverse	26
Oblique	16
Spiral	7
Comminuted	18
Compound	2

Certain comminuted fractures without great displacement of the fragments may be satisfactorily treated with plaster-of-Paris either as the circular "arm and body" case, or by molded splints, although we confess to but little success with the latter Metal splints of the Osgood-Penhallow type are useful, but as a rule we have reserved these for later stages of the treatment

For upper third fractures, a triangular pad in the axilla, shoulder cap, arm to the side and sling, makes a satisfactory dressing where displacement is absent or slight, and in more severe cases, the aeroplane type of splint with or without extension is often successful in bringing the lower fragment into opposition to the upper, which is almost invariably displaced outward and upward by muscle pull

In general it may be said that deformity which can be overcome by suspension and traction will respond to these measures in about a week If at the end of that time there is little or no improvement in position we believe that open reduction should be undertaken Failure to respond to properly applied traction is nearly always indicative of muscle interposition and continuation of conservative measures is a waste of time to patient and surgeon alike

FRACTURES OF SHAFT OF HUMERUS

In our series, open reduction was resorted to eleven times, or in approximately 15.9 per cent of the cases. This is slightly higher than the open reductions upon other bones, which was necessary in 98 out of 1,000 fractures admitted to the Abington Hospital over a period of five years (1928-1932). The indications for operation in the eleven cases were as follows:

Failure to reduce by traction, 6, failure to retain after reduction, 2, compound fractures, 2, old fracture with non-union and bad position, 1. Fractures of the upper third required open reduction oftener than those involving the middle or lower thirds.

In the conduct of the operation certain general rules must be followed. Exposure must be adequate and the incision so placed that the shaft may be exposed for considerable distance without injury to the radial nerve. We have found the approach advocated by Henry to be very satisfactory. Some form of internal fixation is always necessary and our individual preference is for the Sherman steel plate, although many surgeons prefer silver wire or beef bone plates and screws. Before applying any form of internal fixation it is necessary to determine the position of the arm in which the fragments are most easily retained, or in other words, to secure the best muscle balance possible. In this respect, although certain standard positions will be applicable to most fractures, in a sense each case is a law unto itself. This has an important bearing on the dressing of the extremity after operation, for no matter how firmly fragments may be secured by plates, screws, wires or other devices, unless the part be dressed in proper muscle balance, the maintenance of good position will be difficult or impossible. This factor is of the utmost importance in the comfort of the patient after operation. It is our practice to immobilize these cases in plaster-of-Paris, the plaster including the hand, forearm and chest. Patients treated by open operation are permitted to be up in a chair in ten days and usually leave the hospital in fourteen days, returning at the end of four weeks for observation.

TABLE III

Methods of Treatment

Suspension and traction	28
Axillary pad and swathe	17
Splints (including plaster)	13
Open operation	11
	—
Total	69

Whether the case has been treated by suspension and traction or by open operation, union has usually progressed in four weeks to the stage where the fragments are firmly held by callus, and simple and lighter dressings may be substituted for the more cumbersome ones. It is at this time that we employ the metal splints previously referred to. Gentle massage and passive motion are now started and the dressings are changed completely once a week. More frequent revision accomplishes nothing in this type of fracture and may do

harm All dressings may usually be dispensed with at the end of eight weeks In patients who are careful and intelligent, a sling is often all that is required after six weeks

In the sixty-nine cases herein considered the only case of non-union was in a patient seen for the first time twelve weeks after the original fracture A satisfactory result was obtained after an osteoperiosteal bone graft was done Two cases developed musculospiral paralysis but made complete recoveries The hospitalization time averaged 18.3 days The above were the only complications encountered and all other cases obtained excellent results

In conclusion we wish to reiterate our belief that fractures of the shaft of the humerus should be hospitalized whenever possible, that open reduction should be done as soon as it has been demonstrated that conservative measures are not accomplishing reduction and not postponed for weeks, that the importance of immediate splinting and the early institution of definitive treatment applies here as it does in all long bone fractures

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD NOVEMBER 6, 1933

The Vice-President, DR WALTER E LEE, in the Chair

CALVIN M SMYTH, JR., M.D., Recorder

ACUTE STREPTOCOCCIC OSTEOMYELITIS FOLLOWING A SIMPLE FRACTURE OF THE FEMUR

DR WALTER ESTELL LEE and DR J T F GALLAGHER reported the case of a girl of ten years, previously in good health, who was admitted to the Pennsylvania Hospital November 6, 1932, immediately following an automobile accident. There was an oblique fracture of the left femur about six inches below the greater trochanter (Fig 1), in which the distal fragment was angulated fifteen degrees outward. There was a large hæmatoma at the site of the fracture but no break in the skin. The extremity was suspended in a Russell extension apparatus and the course was uneventful for the first three days following admission, when the temperature rose to 101° F, the pulse became rapid and the child became irrational. Examination of the head revealed a decrease in the superficial swelling and contusions of the scalp, but the left ear-drum showed a fiery injection along the handle of the malleolus. The drum did not bulge, however, and it was not incised. The right ear was not remarkable. The patient ran a hectic fever which had gradually subsided ten days after the onset with a disappearance of the signs of otitis and an apparent general improvement.

On the thirteenth day the temperature again rose sharply and there was extreme tenderness with moderate swelling and inflammation at the site of the fracture. A fluctuant mass pointed on the postero-lateral surface of the thigh which was aspirated and 320 cubic centimetres of thick grayish pus mixed with blood were withdrawn. Hæmolytic streptococci grew on the culture. Following the aspiration the swelling promptly reappeared and another tap was made, containing 350 cubic centimetres of pus and blood similar to that obtained at the first aspiration. The hectic fever continued, the fluctuant mass reappeared and two weeks after the development of the infected hæmatoma an open drainage was done at the site of fracture. Under avertin anæsthesia incisions were made along the lateral and posterior surfaces of the thigh, and a large amount of grayish-yellow pus evacuated from beneath the subfascial planes and periosteum. The periosteum was found to be stripped back from the ends of both fragments for a considerable distance. Pus also escaped from the medullary cavity and there was no evidence of bony union. Hæmorrhage from the periosteum was profuse and the vessels could not be ligated due to the extensive necrosis of the tissues. Hæmostats were left in place and the wound packed with gauze saturated with 5 per cent solution of dichloramine-T. The patient left the operating room in profound shock and was not expected to live.

She rallied somewhat after the intravenous administration of 5 per cent glucose in saline and during the following days she received repeated small transfusions of citrated blood. The hæmostats were removed four days post-operatively and there was no hæmorrhage, although the wounds continued to

drain pus freely Carrell-Dakin tubes were inserted and irrigations with normal saline solution every two hours were continued for five days, when the temperature returned to normal The wounds healed by granulation, and bony union began to take place The patient was removed from the extension apparatus 109 days following the accident and discharged wearing a leg brace and in excellent general condition with sufficient callus to allow active motion without weight-bearing There was perfect alignment of the shaft of the femur with no shortening of the leg Along the lateral and anterior aspects, however, the callus was still deficient, and there was a small sequestrum with non-union of the callus at this point (Fig 2)

Eight months following the injury the child resumed her normal activities without the brace The callus increased in density but a small sinus running through the site of the fracture containing sequestra persisted (Fig 3) Ten months following the accident the patient spontaneously expelled a small spicule of bone which on microscopical examination revealed the presence of Gram-positive cocci Following this the wound healed promptly, but only last week the sinus tract reopened with slight drainage, indicating the presence of other sequestra

It is well known that acute osteomyelitis in adolescence is essentially a blood-borne disease, localizing in the metaphyses of long bones An important cause of such localization was determined by Lexer, when he demonstrated the loop arrangement of the capillary vessels in the metaphysis which accounts for the slowing up of the circulation and thus favoring the lodgment of bacterial emboli In early cases of osteomyelitis Clarence Starr demonstrated that the initial lesion is always in the juxta-epiphyseal region and follows varying degrees of epiphyseal separation In adults there is less tendency to well-defined localization of an osteomyelitis and the disease occurs much less frequently after ossification of the epiphyses has taken place Trauma undoubtedly plays an important rôle

The case here reported is one of acute streptococcic osteomyelitis which followed a simple fracture of the shaft of the left femur It exemplifies the hæmatogenous origin of the disease and the determination of the site by the trauma It is also worthy of note as a localized osteomyelitis compared with the massive infection of bone that always takes place where the intramedullary pressure is not promptly relieved A survey of the literature indicates the rarity of such an infection although following compound fractures and amputations it is common enough

DR WALTER ESTELL LEE remarked that the localization of this infection to the immediate area of the fracture is in marked contrast to the massive osteomyelitis which usually develops in pyogenic suppuration of the growing long bones We have taught for some years that this massive destruction of the bone is primarily the result of the increase in the intramedullary pressure without the cavity of the rigid bony tube, resulting from the inflammatory response, to a point greater than that of the blood-pressure within the nutrient vessels With the cutting off of the blood supply massive death of the diaphysis rapidly occurs Infection, though at first a localized process, rapidly involves the necrotic bone In this case the medullary cavity was

ACUTE STREPTOCOCCIC OSTEOMYELITIS

Fig. 1—Rontgenogram at time of accident showing oblique fracture at junction of middle and upper thirds of the left femur



Fig. 2—Rontgenogram three months following accident and after surgical wounds had healed, showing unhealed callus and bone absorption at site of fracture

Fig. 3—Rontgenogram eleven months following accident, showing dense callus formation with sinus tracts and sequestra at line of fracture not sufficient, however, to impair the strength of the bone

decompressed at the time of the fracture, and when the blood-stream infection became localized at this point, although an increased blood supply was brought to the part, it escaped from within the bony cavity through the line of fracture, and therefore, there was no abnormal increase in intramedullary pressure. No better research could have been planned than that provided by this clinical case in which, because of decompression of the medullary cavity of the bone the infection was localized. This certainly seems to bear out our belief that the amount of destruction of bone in pyogenic osteomyelitis of the growing long bones is in direct proportion to the duration of time that increased intramedullary pressure is allowed to continue, and that by very prompt decompression of the medullary cavity by drilling holes in the cortex or by cutting a trough through the cortex, the blood supply is restored to the cortex and death of bone is minimized.

DR HENRY P. BROWN said that a young man of thirty years was admitted to Doctor Hodge's service at the Presbyterian Hospital with a fractured femur which could not be reduced satisfactorily by traction. About seven or eight days later, on open reduction, a collection of serum was found between the ends of bone from which was obtained staphylococci in pure culture. After reduction the wound was closed without drainage, no infection followed and the patient had a primary union.

IMPERFORATE ANUS

DR I. S. RAVDIN presented a boy seven years of age who when forty-eight hours old was admitted in the service of Dr. G. P. Muller in the Hospital of the University of Pennsylvania with the diagnosis of imperforate anus. The child was born on the second of February, 1926. The labor was about nine hours long and was unattended by any difficulties. At birth he was apparently healthy, after two days the child seemed well but no bowel movements had taken place. Examination revealed that he had no anal opening. He was well developed and had no deformities except for the absence of an anal opening. The abdomen was rotund and distended, and moderately tympanic. Peristalsis was hyperactive. There was no anal opening nor any sign of a pit or bulge in the perineal region. The child was operated upon by Dr. I. C. Ravdin on the day of admission, with "sugar-tit" anaesthesia. An incision was made in the perineum from the posterior edge of the scrotum to the tip of the coccyx. By careful dissection and keeping quite close to the curve of the coccyx and sacrum, the incision was carried up to the cul-de-sac of the peritoneum. At that time no bulging of the non-descended rectum was noticeable. By measurement they had gone nearly six centimetres. After a little more dissection a bulge during inspiration was noticeable and there was finally disclosed a blue mass bulging into the wound (Fig. 4). This was opened and about 250 cubic centimetres of meconium with gas were immediately evacuated. After evacuation of the bowel it was possible to bring the gut down to the edges of the wound where it was sutured with six sutures of black silk. A piece of iodoform packing was put on either side of the wound between the rectum and the perineal tissues and a rubber tube was inserted into the lumen of the bowel.

At the conclusion of the operation the child was given 50 cubic centimeters of citrated blood by intraperitoneal route.

IMPERFORATE ANUS

No inhalation anaesthesia was given at any time during the operation and the child did not seem to suffer any great amount of pain, in fact he slept during the greater part of the time.

Two days after the operation the bowels moved three times during the night. The temperature rose sharply to 105° F but the general condition was satisfactory. It was taking mother's milk—two ounces, every three hours. On the fourth day following the operation the condition was satisfactory although the child continued to run a temperature of about 103° F. The bowels moved two or three times that day. On the sixth post-operative day the tube and the skin stitches were removed. The wound was clean. The temperature rose to 105° F again on this day but the general condition seemed fair. The lungs remained clear. Two days following this the temperature fell to 100° F. Ten days after operation the wound was clean and healing nicely, and the temperature was normal. There was still a granulating surface but the bowels moved regularly. From the time of discharge dilatation of the anal opening was practised but the stricture became increasingly firm.

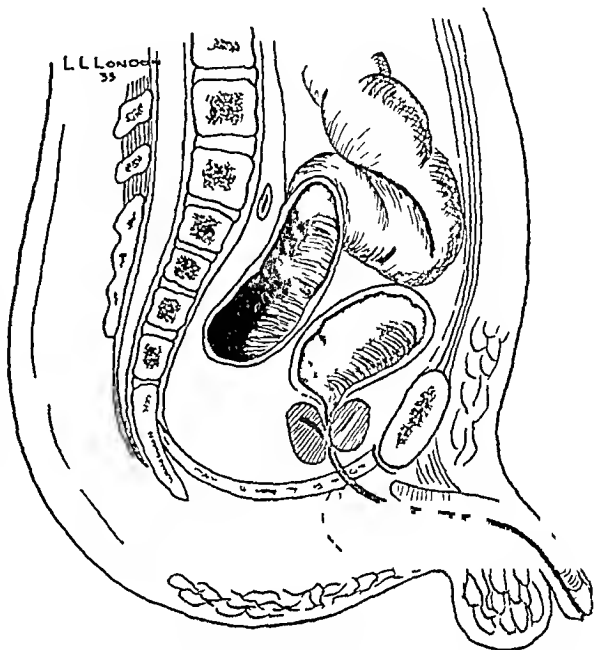


FIG 4—Terminal state of rectum as disclosed at operation

On June 1, 1931, the child was again admitted to the hospital with a rectal stricture. On the following day a plastic operation was performed. The stricture on one-half of the anus was excised and the mucous membrane sutured to the skin around the anus. Fourteen days later a similar operation was done at which time was removed the remainder of the scar which was causing the stricture.

The child has grown normally and is in excellent condition. Except when his movements are loose he controls his evacuations. He attends school and participates in games with his schoolmates.

While there has been an increasing tendency to resort to inguinal colostomy for the primary operation the perineal route would seem to be the preferable exposure unless the blind end of the colon hangs free in the peritoneal cavity. If adequate exposure is obtained and the tissues are gently handled the operation should not be attended by much shock.

IMPERFORATE ANUS—END-RESULT

DR WALTER ESTELL LEE and DR N P SHUMWAY presented a male infant born in the Philadelphia Lying-In Hospital November 6, 1931. He was the first child of rather elderly parents. The delivery was prolonged and rather severe by reason of a breech presentation. Upon admission to the nursery on attempting to obtain the rectal temperature absence of the anus was discovered, this was reported immediately to the attending physician but because of the child's general condition it was determined to wait for some improvement before attempting surgical relief. After fourteen hours' observation there was some general improvement, but abdominal distention

was rapidly increasing and there was slight but persistent regurgitation of fluids, the child was restless and cried continually. Examination at the time revealed total absence of an anal dimple and there was no bulging or thrust of the perineum upon straining. Colostomy was, therefore, performed fifteen hours after delivery. Six and one-half hours later there was sufficient plastic peritoneal reaction to have securely walled off the abdominal cavity and the gut was opened longitudinally with a nasal tip cautery. There was immediate discharge of meconium. The supporting catheter was removed three days later.

The patient had no post-operative reaction and his subsequent course

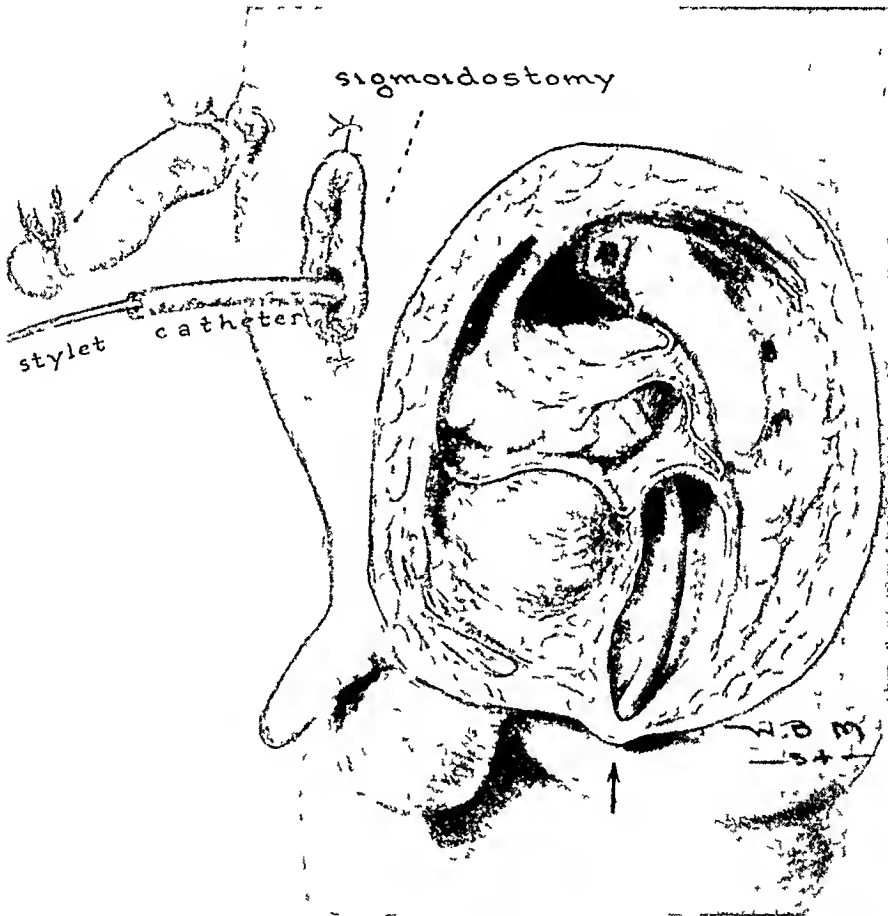


FIG 5—Sigmoidostomy subsequently followed by perineal section under guidance of a catheter introduced on a stylet through the opening in the sigmoid

was most satisfactory, showing a progressive gain in weight. The only complication was a tendency toward excoriation of the skin about the wound. This was best controlled by a liberal use of vaseline-gauze dressings and the institution of an acidophilus milk formula.

On the thirty-fourth day after delivery a small catheter, No. 10F, was inserted through the colostomy opening into the distal segment of the bowel, through this, iodized oil was injected with a resulting visualization of the rectal pouch. By comparison with an opaque marker on the perineum the rectum appeared to be about one inch away, the pouch was quite clearly seen and there seemed to be a conical extension beyond the main bulb toward the anal region.

An attempt was made to connect the rectum with the perineum on the forty-first day of life, anaesthesia being successfully obtained with whiskey water. Under fluoroscopical control a No. 16F soft rubber catheter with blunt tip was inserted into the lower loop of the sigmoid through the colostomy, some difficulty was met with in pushing the catheter into the rectum because of coiling, which tendency was obviated by threading a fine wire stylet into the tube, which also added to its opacity to the X-ray, affording very satisfactory visualization (Fig 5). The exact position of the rectum having been determined by this means, incision was then made through the perineum. No muscular tissue being met with, the dissection was carried toward the rectum until the catheter could be readily palpated and finally grasped and brought out through the wound—a distance of approximately three centimetres. The rectum was not mobilized and the perineal wound was closed about the catheter with two skin sutures of dermol. By this procedure the possibility of opening into the peritoneal cavity was prevented. There was no shock post-operatively and there was a rise of temperature to only 100° on the following day, other than this there was no untoward reaction. The catheter was removed at the end of eleven days and another of the same calibre reinserted through the colostomy wound, this procedure was followed at weekly intervals thereafter for the first month after operation, when the catheter was no longer inserted from above, that portion connecting the rectum with the anus alone being maintained. On the forty-fifth day after perineoplasty there were free faecal passages by rectum. Three months after operation the child was discharged from the hospital to be followed in the Surgical Out-Patient Department, there the routine has been a weekly insertion of a mushroom catheter into the rectum.

Examination at the present date shows a well-developed and active child, weight twenty-eight pounds, with a left-side colostomy wound which occasionally discharges faecal matter. The rectal examination reveals a tract which will just admit the little finger, its wall is covered with rectal mucous membrane extending almost to the perineum. The surrounding tissue is firm and indicates that continual dilatation will be required to maintain its patency. There is, of course, no control of the evacuations since the catheter is still being inserted at weekly intervals.

Congenital imperforate anus is not a common complication of infancy, occurring but once in 5,000 to 10,000 births, however, it is a condition which being present usually demands immediate surgical treatment. Like most other congenital defects it is frequently complicated by atresia of some other portion of the intestinal tract, by cardiac malformations, or genital deformities which as a rule make the prognosis poor, even without a second deformity the outlook is not exceptionally good, for many writers upon the subject are of the opinion that the rectal anomaly itself exerts a retarding effect on the foetal development in utero. This is an important factor in the determination of the type of surgical procedure to be used, in that one is dealing with a patient who demands the least trauma possible.

The etiology of the condition lies in the embryological development of the portion of the gut at fault, this fact was most clearly elucidated by Keith in 1908, and it was upon this basis that he proposed a most satisfactory classification of the various types of deformity found in this region. Up until the tenth or twelfth week of foetal life the hind-gut and the Wolffian

body form a common cloaca, these rapidly separate and the hind-gut pouches down to meet an invagination of the proctodeum which forms the anus, fusion taking place at about the twelfth week. This process is based upon the evolutionary development of the vertebrates and really amounts to the migration of the anus from an intracloacal position, as found in the frog, to an extracloacal or perineal position. With this as a basis we are able to determine the three groups into which all deformities must fall. First those in which the rectum empties into the urogenital tract, second, those in which the hind-gut is imperfect, third, in which the proctodeum is imperfect. It is obvious from the development of the region that any one or all three may occur with any combination of them together, and when it is further realized that the internal and external sphincters are a part of the proctodeum we must conclude that the external examination of the parts does not give any indication as to the exact condition present. Thus we may have a normally formed anus and yet the rectum be anywhere from one-sixteenth of an inch to two inches away from the perineum. This is the second fact which must influence our decision in the matter of surgical approach.

Limiting the discussion to the condition found in the case reported, namely, a combination of the second and third types, it may be said that the symptomatology of the condition varies with the time elapsing between birth and the surgical intervention resorted to, that is, if the period is lengthy the cardinal signs and symptoms of acute intestinal obstruction may be expected.

Mortality in this condition is rather high, death being certain if no operative procedure is resorted to, the figures for those operated upon give as a rule a total mortality of about 25 per cent. Brenner, reporting sixty-one cases, gave 26.2 per cent although of these but three were of the type with complete occlusion. Of 104 cases collected from the more recent literature the total mortality was 20.2 per cent.

Of the various operations performed for the relief of imperforate anus the one which suggests itself most readily is that first employed by d'Amussat, which consists in a dissection of the perineum with search for the rectum and its mobilization so that it may be brought down to its proper position. This method is the one chiefly favored. The second route is that of colostomy with perineoplasty. A third method is that of colostomy with secondary perineoplasty. A fourth method is mentioned and condemned by all writers, that of blindly searching for the rectum with a trocar. Here the danger lies in piercing Douglas' pouch, which often lies between the perineum and the rectum, with subsequent peritonitis.

The first method described is advocated by the majority of men who have written upon the matter, and in a greater part of the statistics it has had the lowest mortality, thus in Brenner's series of twenty-nine cases operated on by direct perineoplasty the mortality was 24 per cent. of the eleven in whom colostomy was performed the deaths amounted to 66 per cent. However, it was our feeling that in general the statistics against primary colostomy

IMPERFORATE ANUS

are deceiving in that often it had been resorted to only after perineal search had failed, and consequently the child had been subject to a great deal of trauma. With this in mind we have grouped the 104 cases from recent reports into those in whom perineorrhaphy was primary, sixty-three with a mortality of 22.2 per cent, colostomy, twenty-two with a mortality of 18 per cent, and the combined, sixteen with a mortality of 68.7 per cent. In this it is seen that if the last two are combined the mortality for colostomy is 39.4 per cent, whereas the corrected deaths are actually lower than the 22 per cent found in the type of operation chiefly advocated, moreover the perineal route is successful in only 80 per cent of the cases, the remainder requiring colostomy as a last resort. Recently, however, Wangenstein and Rice have described a method of determining the position of the rectum by X-ray which should reduce the mortality for the perineal route, they advocate the placing of the child in a head-down position in order to allow an accumulation of gas in the rectal pouch with subsequent roentgen examination to definitely localize the end of the gut. This entails a certain delay in operation, at least ten to twelve hours being required for the formation of a sufficient quantity of gas to outline the rectum, and while many believe that operation may be postponed for twenty-four to forty-eight hours, yet this idea is certainly contrary to the principles of surgery in the treatment of intestinal obstruction. Further, the intestinal tract of the child during the first thirty-six hours of life is generally thought to be sterile, and since gas to be present must be preceded by the gas-forming organisms, operation by this method is being put off until there is an infected field, a totally irrational procedure.

Primary colostomy, as performed in the case reported by us reveal no delay, was borne well by the patient, and permitted subsequent use of a method by which the rectum was accurately visualized before and during the secondary perineal repair.

The literature contains mention of similar visualization of the rectal pouch with an X-ray-opaque substance injected through the colostomy wound by Doctor Hirschman of New York while discussing a paper by Doctor Landman in 1926. We have not found any report of the use of an opaque catheter and fluoroscope as was done in our case at operation.

Dr. I. S. RAVDIN said that his patient, of course, had no sphincter because there never had been any. The ideal thing to do for this child is the operation for anal incontinence described under several names but which should probably be credited to Harvey Stone. This operation consists in slinging two strips of fascia around the anus by passing them subcutaneously from the gluteus maximus muscles, the strips pass around the sides of the anus opposite to the muscles from which they start and interlock with each other. Control is afforded by contraction of the glutei, which in turn tightens the fascial ring. The speaker proposes to do this operation sometime in the near future.

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DR GEORGE M DORRANCE mentioned a patient who is at present under his care in whom the perineal operation was unsuccessfully attempted. On opening the abdomen the blind end of the bowel was found to be adherent to the bladder and colostomy, was, therefore, performed. Now there is a prolapse of about eight inches of sigmoid through the abdominal wound.

FRACTURES OF THE CAPITELLUM OF THE HUMERUS

DR WALTER ESTELL LEE and, by invitation, DR THOMAS SUMMEY, read a paper with the above title for which see vol 99, page 497.

SPINAL ANALGESIA—A REPORT OF FIFTEEN HUNDRED CASES

DR ORVILLE KING, by invitation, read a paper with the above title.

PRIMARY CARCINOMA OF THE COMMON BILE-DUCT

DR WALTER ESTELL LEE and, by invitation, DR H P TOTTEN read a paper with the above title.

TUBERCULOSIS OF THE BREAST

DR WALTER ESTELL LEE and, by invitation, DR HARRY G FLOYD read a paper with the above title for which see vol 99, page 753.

DR I S RAVDIN recalled a case operated upon by the late John B Deaver in 1920 which had been operated upon previously by E G Alexander for a breast tumor. Examination of the tissue removed by Doctor Alexander showed adeno-carcinoma. Six months later an ulcerated lesion about three centimetres in diameter appeared on the same breast. Doctor Deaver did a radical resection of the breast. The histological studies disclosed an associated carcinoma and tuberculosis in the same breast. In 1854 Rokitsky states that tuberculosis and carcinoma in the same individual, and more especially in the same organ, were incompatible. This has since been shown to be a fallacy.

DR STEWART RODMAN recalled a case that occurred in his father's practice which has proven the association of tuberculosis and carcinoma in the same breast. The pathological diagnosis was confirmed by the late Doctor Copeland.

In so far as the treatment is concerned, most of those who have written on this subject advise resection of the diseased areas. As he had seen recurrences following this procedure, the speaker now practises and believes it to be the operation of choice—simple amputation.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD DECEMBER 4, 1933

The Vice-President, DR WALTER E LEE, in the Chair

CALVIN M SMYTH, JR, M D, Recorder

TOXIC GOITRE WITH PARALYSIS OF EXTRA-OCULAR MUSCLES

DR EDWARD J KLOPP and, by invitation, DR E G SHANNON, presented a man aged forty-five, a coal miner by occupation, who was admitted to the Jefferson Hospital, September 29, 1933, with the diagnosis of exophthalmic goitre. His chief complaints were nervousness, excessive perspiration, marked tremor of both hands, palpitation of the heart, staring of both eyes, diplopia and loss of weight. He has been a miner for the past twenty-five years, working from seven to eight hours per day, and has never been financially distressed. In August, 1932, there was an onset of marked nervousness with tremor of both hands and perspiration of the entire body. There was some gastric disturbance in the early part of August, during which he vomitted once. He was treated by a physician who diagnosed his case as "miners' asthma" on account of cough, expectoration and shortness of breath on exertion. He has not been able to work for the past five months.

The spinal fluid was practically normal. The Wassermann and Kahn reactions were negative. Metabolic rate on September 30 was plus 51, October 10, plus 29, October 18, plus 17, October 27, plus 15, and November 17, plus 25.

The patient was prepared for subtotal thyroidectomy by rest in bed and small doses of Lugol's solution. At operation under avertin, supplemented with nitrous-oxide anaesthesia October 31, 1933, nothing unusual was encountered. The most important symptom was the unusual paralysis of some of the extra-ocular muscles.

During his first illness in August, 1932, there was no clinical evidence of any ocular impairment. He was able to return to work in October. In January, three months later, he developed tearing of the right eye, followed by marked oedema of the right eyelid. With the subsidence of these symptoms he found he could not raise the right eyeball and that all objects appeared double except in the lower field. Five months later, the left eyeball was similarly affected and on October 2, 1933, both eyes exhibited an almost complete paralysis of the upward movements of both eyeballs, indicating an involvement of both superior recti muscles. In addition, the inferior oblique muscles were affected as no upward-outward rotation could be obtained. The inferior recti muscles being unopposed, it was noted that both eyes were turned definitely downwards, the right eye slightly lower than the left (Fig 1). The left eye could be elevated slightly, the right eye apparently not at all. With binocular single vision obtained only in the lower field, it was necessary for the patient to tilt his head rather sharply backwards. Since the subtotal thyroidectomy on October 31, a little over a month ago, he feels

that he can now bring his head nearer the erect position and still maintain single vision

In attempting convergence, the right eye looked straight ahead while the left deviated in slightly It is also interesting to note that with the eyes rotated to the extreme right the right eye turned downward, while with the



FIG 1.—Toxic thyroid with paralysis of the superior recti and the inferior oblique muscles of both eyes with slight impairment of function of the externi and interni muscles

eyes rotated to the left, the left eye was similarly deviated downwards, indicating an over-acting superior oblique muscle In addition to the paralysis of the superior recti and inferior obliques, the function of the externi and interni muscles was slightly impaired The fields for white and color were within normal limits and the eye-grounds, aside from some angiosclerosis, were negative.

TOXIC GOITRE WITH PARALYSIS OF EXTRA-OCULAR MUSCLES

The ocular symptoms that may accompany Graves' disease naturally draw the interest of the ophthalmologist. The symptoms were striking and important and it seems appropriate in connection with this report, before touching upon the unusual muscular complication in this case, to briefly enumerate them.

The explanations for the development of this condition are varied and as follows:

That it is due (1) to engorgement of orbital vessels, (2) to contraction of unstriated muscle fibres in the orbit, running from the equator of the eye to the orbital septum, (3) to deposition of fat in the orbit with œdema of ocular muscles. According to Foster-Moore⁶ the last explanation is the most tenable.

The speaker remarked that paralysis of the extra-ocular muscles in toxic goitre is rarely seen. Cases have been reported by Ballet,⁷ Liebrecht,⁸ Buschan,⁹ Manheim,² Lang and Pringle,¹⁰ West¹¹ and others, in some of which other cranial nerves have been involved. Palsy of the intrinsic muscles—sphincter of the iris and ciliary body—has not been recorded nor cases of associated movements of the eyes, with the exception of cases of paralysis of convergence by Schmidt-Rimpler¹² and Vossius.¹³ The occurrence of paralysis of, first, the right superior rectus and five months later, of the left superior rectus, would not support the view that this case was one of an associated paralysis of the superior recti. Bristowe¹⁴ reported a case of ophthalmoplegia externa in a young man three years after the symptoms of Basedow's disease had developed. Later loss of smell and taste occurred. Warner¹⁵ had reported a case of binocular external ophthalmoplegia with palsy of the facial and trigeminal nerves. Voss¹⁶ has reported two cases of palsy of the extra-ocular muscles in exophthalmic goitre. Brain¹⁷ has recently reported five cases of enlarged thyroid and muscular disturbances. He offered no explanation of the relationship between the two conditions.

The interesting question arises as to the cause of the defective ocular movements. Various theories are advanced but the most acceptable is that of Foster-Moore,⁶ who believes that they are due to changes in the muscles rather than in the nerve of supply, a view, as he states, "which is supported by the distribution and by the fact that definite changes have been found in the muscles." This change, as he noted in one of his cases, was due to fatty infiltration of muscles.

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DR THOMAS A SHALLOW remarked that one could hardly believe that the same lesion which produced the bone changes in this man was responsible for the blindness and deafness. When we consider those factors about the eyes and ear, we are struck by this fact that in oxycephalus, which is a condition known as tower head, there is an early fusion of the sutures at the base of the skull. As a result, the subsequent development of the brain makes pressure and destroys some of the basal structures, particularly the first, third, fourth and sixth nerves. This belief is fortified by Doctor Keele's Baranay test and by Doctor McAndrew's study of this child's eyes. There is quite a dispute about the consistency of the bone. Some agree that the bones are soft, others say that they are hard, and a review of the pictures shown by Doctor Davis indicates there has been softening at some time. There is no history of fracture, so here we have a condition which resembles Paget's disease and the reports of other cases show there is only bending as in this patient, but there is softening and, at a later stage, hardening of the bones.

When we consider the pathology in osteitis fibrosa cystica, which is caused by hyperparathyroidism and find that this produces osteoporosis and cystic change in the bone, we cannot help, by comparison, to classify osteopetrosis as hypoparathyroidism, since excessive lime-salt deposits are found in this disorder.

SOLITARY CYST OF THE FALCIFORM LIGAMENT

DR HENRY K SEELAUS remarked that among the 107 reported cases of solitary non-parasitic cysts of the liver, only three have been recorded as occurring in the hepatic ligaments, two in the falciform ligament, one by Dujarrie and the other by Wakely and MacMyn, and the third, in the round ligament by Bevan. The present report constitutes the fourth recorded case.

The patient, a girl, aged seven, was admitted to the children's ward of the Jefferson Hospital in the service of Doctor Bauer, July 11, 1933, with a diagnosis of hepatic cirrhosis with ascites. The present illness began three years ago with an enlargement of the abdomen which had gradually but progressively increased. In November, 1931, she was operated upon in another city, the operative note being that the liver was increased to ten times its normal size with an accompanying ascites. Nothing further was done and

SOLITARY CYST OF THE FALCIFORM LIGAMENT

the incision was closed without drainage, healed without complications and the patient sent home in ten days. Following her discharge from the hospital the abdominal enlargement increased and she was referred to the Jefferson Hospital. On physical examination the abdomen was markedly enlarged, distended and rounded, the superficial veins, including those of the umbilical region, being very much dilated. There was fluid present, the characteristic wave being elicited. An X-ray film of the abdomen confirmed the findings regarding fluid but there was so much fluid present that it prevented any further interpretation regarding any abdominal masses. A film of the pericardium and heart was negative for any evidence of Niemann-Pick's disease. The bromsophalein retention study of the liver indicated normal hepatic function, there was a positive indirect van den Bergh reaction and the quantitative van den Bergh study was 42 mg per 100 cc of blood. Under the impression that we were dealing with an instance of juvenile hepatic cirrhosis with ascites the abdomen was opened under ether anaesthesia through an upper Moynihan incision. Instead of finding an enlarged liver with ascites we encountered a large cyst adherent to the under surface of the liver and the great omentum. Being mindful of Wangensteen and Scott's work on shock following the sudden removal of large amounts of fluid from the peritoneal cavity we incised the fibrous wall of the cyst and with the aspirating set evacuated the cyst by gradual decompression, removing 3,850 cc of a brownish, muddy fluid. The collapsed cyst was then easily shelled out from the folds of the falciform ligament and the under surface of the liver. The gall-bladder and the extrahepatic bile-ducts were entirely separate from the cyst and after its removal the two leaflets of the falciform ligament were brought together with a few interrupted catgut stitches. The oozing from the raw surface of the liver was controlled by pressing a hot moist gauze pad against it. The abdomen was closed with one cigarette drain carried down to the hepatic area. The patient reacted well from the operation and was discharged from the hospital three and a half weeks afterwards.

The fluid contained albumin and blood, no bile, a few pus-cells and many red blood-cells and debris.

Pathological Examination by Doctor Crawford—Specimen consists of a cystic mass which has been emptied of its contents weighing 575 Gm and measuring 19 by 17 by 15 cm. The external surface is white, smooth and glistening, and there are several ragged areas about 2 cm in diameter, scattered over the surface. The cyst wall varies from $\frac{1}{4}$ cm to $1\frac{1}{2}$ cm in thickness. The wall is composed of a very dense grayish white tissue. The inner surface is smooth and covered with a slimy, brownish-yellow material.

Histology—Examination of sections from the wall of the cyst reveals that it is composed of very dense fibrous tissue, in some places, the tissue is hyalinized. No other structure such as muscle tissue is observed, and in the number of sections examined no evidence of an epithelial lining to the cyst could be demonstrated.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD JANUARY 8, 1934

The President, DR WALTER E LEE, in the Chair
CALVIN M SMYTH, JR, M D, Recorder

FRACTURES OF THE LOWER END OF THE HUMERUS

DR WILLIAM BATES read a paper with the above title for which see page 1007

DR IRWIN E DEIBERT said after reducing these fractures under the fluoroscope an attempt is made to throw them out of position by allowing the arm to hang loosely, thus ascertaining whether or not the fragments will become easily displaced. Once the fragments are placed in good position it is more or less difficult to throw them out of alignment. A simple dressing is applied in order to permit early motion, plaster being rarely used in this type of injury because of the tendency always to leave plaster on too long. Early motion, moving the part through the widest angle without the production of pain and supporting the fracture site is certainly productive of good results. If satisfactory reduction is not obtained immediately by simple methods an open operation should unhesitatingly be undertaken. It is the delay of an open procedure that is quite often the cause of a deformed or poorly functioning arm.

DR HARRY E KNOX remarked that in fractures involving the joints, particularly in the young and the aged, surgeons are prone to over-treat patients. In children with fractures of the lower end of the humerus and in those involving the elbow, fixation after reduction should apply until swelling has subsided and disappearance of pain, which usually requires from ten days to two weeks. The arm should then be removed from acute flexion to right angles, being maintained only by a sling, passive motion instituted, and active motion encouraged. By the end of three weeks the child will usually have little interference with function and by the end of four weeks can usually be discharged.

Complete reduction, while highly desirable, is by no means always necessary or possible for a good functional result. These fractures are to be treated individually and not to be viewed from a "standard." While the ideal should be the goal, it is not always possible to get a "cabinet maker's result."

DR WILLIAM JOHN RYAN has never seen a supracondylar fracture which was caused by a fall on the outstretched hand. Those he has seen were caused by falling directly on the elbow, or, the elbow was struck by another

FRACTURES OF THE LEG BELOW THE LOWER THIRD

object while the individual was falling. In "T" or "Y" fractures, one frequently has wide separation of the lower fragments and Doctor Ryan has not been able to reduce them without open operation. It is necessary to bring the two lower fragments together with a screw or bolt or wire and then align them as one fragment with the upper.

DR I. M. BOYKIN said that the mistake is often made in supracondylar fractures of attempting to reduce them without deep anæsthesia. The unreduced fracture is then dressed in acute flexion, resulting in circulatory impairment with swelling and vesication. After swelling has taken place it is futile to make further attempts at closed reduction. Recently the speaker has had under his care three such cases. They were dressed in full extension and an open reduction done when the swelling had subsided. In none of these cases was mechanical fixation necessary. In the post-operative care it is important to institute early weight carrying. This is much more preferable to active or passive motion and causes no pain.

FRACTURES OF THE LEG BELOW THE LOWER THIRD

DR ADOLPH WALKLING read a paper with the above title for which see page 1009.

DR LOUIS D. ENGLERTH said that Doctor Walkling has covered very well the treatment of the non-displaced simple fractures with which the speaker agrees.

In the simple fractures with displacement early reduction is paramount. These fractures should be classed as emergencies. Reduction is often easily obtained early, prior to swelling and fixation of the tissues by hæmorrhage, coagulation, and shortening. Anæsthesia is necessary as a rule. A fluoroscope is of distinct advantage. Following reduction, fixation in proper anatomical position is accomplished by means of a well-fitting, properly padded plaster case extending from the toes to above the knee. This is cut anteriorly or better still on both sides into an anterior and posterior shell. This allows inspection at any time, subsequent massage and manipulation, and can easily be shortened to below the knee at the proper time. One does not wait for swelling to go down. Early adequate reduction as an emergency treatment minimizes swelling. A plaster case splint is no more conducive to damage than any other method of fixation. Damage results from improper application and after care. Doctor Englerth uses the fracture box occasionally, usually as a preliminary splint and in patients kept in bed for some other reason.

Failure of reduction calls for more active treatment, preferably some form of traction most effectively obtained in this region by the skeletal method. Failing in this one considers open operation, the method of fixation depending on experience, judgment and type of fracture.

Treatment of compound fractures is always much discussed. Every compound fracture case should receive tetanus and gas bacillus antitoxin to be repeated if necessary. The speaker confessed that most of the time it is im-

possible for him to tell whether a compound fracture is from within or from without and he believes that this is academic rather than practical and from a clinical standpoint pays very little or no attention to it

Every case of compound fracture is an emergency and should be treated as such. The term compound fracture centers one's interest on the bone whereas other considerations are of equal importance. The treatment which he practices is as follows. The patient is prepared under anæsthesia. The wound is protected with sterile gauze and the external surface is cleansed with soap and water and shaved. After further cleansing and sterilization the wound itself is thoroughly cleansed, irrigated, and mechanically and chemically sterilized, this being the most important phase of the treatment. Debridement and excision of the edges of the skin is practiced. Considerable time is devoted to the process.

At times the question of amputation arises. Under no circumstances is this to be performed in the presence of any evidence of circulation in the foot and even in the absence of circulation the patient should be given the benefit of the doubt and several days allowed before amputation is considered. No harm can be done in waiting. After thorough cleansing and débridement, further treatment is carried out. If, as often in this region, the ankle-joint is open, it should be closed after thorough irrigation and sterilization.

We now centre our attention upon the fracture. If reduction can be accomplished and maintained, that is all that is necessary. However, if reduction cannot be easily maintained some form of traction may accomplish the purpose. If this is not feasible, the fracture should be fixed by some recognized method such as plating, wiring, nailing, suturing, the use of clamps or bands. Judgment as to the method is necessary.

Attention is now centred upon the wound itself. If sufficient tissue is present the wound is closed without drainage. This requires considerable judgment. By a relaxing incision in some portion of the leg one is sometimes able to pull over sufficient tissue to cover the injury to the bone. A voluminous dressing is applied after closure has been accomplished. A large case is then applied extending above the knee down to the toes with the parts in perfect anatomical position. At times the Thomas splint is used.

If closure of the wound is impractical one selects a recognized method of treatment, either that advanced by Orr, with which he has had favorable experience, or by means of Dakin's treatment or some other antiseptic treatment until the wound closes. In some cases in which the wound has been allowed to remain open plastic surgery or skin grafting is later indicated.

DR THOMAS RYAN said that he uses the fracture box at the Misericordia and Fitzgerald Mercy Hospitals as an emergency dressing only. Reduction is performed within twenty-four hours, under nitrous oxide or novocaine, and then a plaster case is applied, which is split down the centre and a bandage applied to keep it intact. He does not believe any injury can occur from early application of a case, in fact, it is very beneficial and relieves the

FRACTURES OF THE LEG BELOW THE LOWER THIRD

patient's pain early Regarding the period of time at which these patients should bear weight he does not believe that one can set any definite time but must be guided by union of the fracture based on X-ray The sprain fracture, to his mind, should be placed in a case on account of the injury to the lateral ligaments of the ankle-joint, which requires four to six weeks for healing The patient should not be allowed to walk early on this account As far as the Steinman pin is concerned he has never found it necessary to use it in fractures below the lower third Rather than raise the inner sole of the shoe it is better to apply a steel arch which supports the arch and the internal aspect of the foot

As far as compound fractures are concerned Doctor Ryan does not feel that it matters whether they are from within out or from without in Débridement to remove devitalized tissue and this procedure should be instituted when the amount of devitalized tissue associated with the fracture warrants it The Orr treatment far excels any other form of treatment for compound fractures that has yet been advanced

DR IRVINE M. BOYKIN remarked that one of the prerequisites to the treatment of fractures generally is an understanding of the mechanism by which the fracture is produced This is particularly true of the fractures in the lower third of the leg With the exception of those fractures due to direct violence, the fractures of the lower third above the ankle are produced by the same forces which bring about fractures of the ankle, differing only in degree

The most comprehensive classification of these fractures is one based on the mechanism which produces them (Ashhurst and Bromer)

(1) Outward rotation of foot (60 per cent) Spiral fracture of fibula Fracture of internal malleolus (2) Fibular flexion (20 per cent) Fracture of internal malleolus Fracture of fibula in lower fifth (3) Tibial flexion (13 per cent) Fracture of external malleolus Fracture of internal malleolus (4) Landing on foot from height T or Y fracture of tibia

Fractures in the lower third, except those due to direct violence, occur while the patient is walking The foot is caught, the body keeps moving or the individual slips and falls on his foot

The diagnosis before swelling occurs can be made by digital examination, after swelling has occurred an X-ray is necessary

As to the treatment of these fractures the speaker's feeling is that the fracture box has no place in the treatment of fractures in the lower third of the leg except perhaps as a splint for transportation Any fracture which can be treated by this method can better be treated by the application of an adhesive-plaster boot The objections to the use of the fracture box are

(1) There is no extension (2) It does not maintain reduction properly (3) When opened for any purpose further displacement of fragments tends to occur

A preferable method for the treatment of these fractures is one which
 (1) Permits reduction without anæsthesia and without manipulation (2)
 Is ambulatory and permits weight bearing (3) One which secures union
 with free motion of the ankle-joint (4) One which gives the shortest
 period of disability

These points of advantage are all embodied in the Delbet method. No anæsthesia is required, reduction is secured through weight extension without manipulation. After the first week or ten days the patients become ambulatory, gradually bearing more and more weight. When union is firm and the splint can be removed it is found that the patient has full flexion and extension of foot. The period of disability is shorter. It has been statistically shown that the average period of disability in fractures of the lower third of the leg is five months. Ashhurst and Crossan in summarizing the end-results of 120 cases treated by Delbet's method at the Episcopal Hospital found that the period of disability was reduced to three and a half months.

The method has some disadvantages, *viz* The splints are difficult to make, the method is applicable only in hospital practice and requires a certain amount of skill. It is not applicable, except in rare instances in compound fractures, and in those cases with posterior dislocation of the astragalus. In spiral fractures of the middle of the lower third with posterior sagging of the lower fragment it is again not applicable. In the exceptions just mentioned we use skeletal traction in conjunction with molded plaster splints. When some union has taken place and the soft parts permit, the Delbet splints can then be applied.

Certain definite precautions must be taken to obtain the best results and prevent complications in using the Delbet method. The splint is applied as soon as the patient is admitted to the hospital. Reduction is obtained and maintained by weight extension, the splints being applied with the extension on. When the plaster has set the extension is removed, the leg elevated on pillows and ice applied to control swelling. Active motion of the ankle- and knee-joint is carried out daily. As the swelling subsides the splint becomes loose and must be reapplied before the patient is permitted to walk. When walking is permitted the patient is instructed in the use of crutches and in the necessity of elevating the limb when not in use. In many instances it is necessary to reapply the splint several times before it can be removed entirely. Pressure necrosis can be prevented by the proper application of the splint and the proper instruction to the patient as to how to care for his leg. The use of a special shoe following the removal of the splint is of prime importance in preventing flat feet.

It is obvious in the teaching of undergraduate students that other methods of treatment must be taught them because as previously stated Delbet splint is applicable only in hospital practice. Other methods which may be taught and which can be applied in home or office are

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(1) Boehler's splint, which is a circular case in which is incorporated a steel loop which passes beneath the instep and on which weight is borne

(2) Molded plaster splints can easily be applied under any conditions. The method has the disadvantages, however, of not permitting weight bearing

(3) Split case is also a method which may be used

Regardless of the method of treatment which one selects we will all agree that the earlier these fractures are reduced and splinted, the better our results

DR ELDRIDGE L. ELIASON said that immediate reduction means the earliest possible moment that reduction can be accomplished with safety to the patient. Two years ago the speaker analyzed some facts and figures on the time that elapsed between the ultimate reduction of the fracture and the time of the accident, and the average time in the long-bone shaft fracture was twelve hours. The man who applies the Delbet splint and does not keep his patient under close observation is going to get in trouble. This brings up the question of individuality in treatment of the fractures. One man should supervise the care of a fracture, not that he has to take care of each fracture each time it is seen, but his concepts of how it should be done should be transmitted to the man who looks after it, and he himself should see that fracture periodically. In the speaker's experience, most of the patients with bad results, such as they see at the Philadelphia General Hospital, give the history of being reduced, only after the swelling has been allowed to subside, which may be three days or two weeks and then sent out to be treated by a second person who does not take the same interest as the man who reduced the fracture. One of the speakers said the cabinetmaker's reduction is not necessary and should not be attempted. Literally, this is true. It is also true that the better the approximation the better function one can generally expect. Experience tells us many times that an imperfect reduction with a live patient and functioning limb is better than a cabinetmaker's reduction with loss of function due to injudicious open reduction.

Today emergency reduction is advocated. This means reduction at the very earliest possible moment that the safety of the patient permits. It means that the surgeon, the X-ray man, and if needed, the anæsthetist, get on the job, at any hour, day or night, Sunday or holiday.

One of the essayists advocates the use of the fracture box as a method of treatment. This is a very poor appliance and personally Doctor Eliason has not used one for more than twelve years. He regards it as a museum piece. The plaster case mentioned is a dangerous dressing in average hands. The Philadelphia General Hospital is the melting pot, or rather the clearing house, for the poor results in the other forty-three hospitals in this vicinity and we see some terrible wrecks, deformities and pressure sores from this type of fixation.

The ambulatory Delbet dressing has doubtless given good results in the hands of Doctor Crossan and Doctor Boykin, but it is a dangerous dressing applied by the average man with little experience.

DR HUBLEY R OWEN said that he made some drastic statements in his paper concerning the faulty management of fractures in some of the hospitals. He could substantiate these statements. He sees some very bad results of fractures treated by other surgeons. Fortunately for him, no other surgeon sees his poor results because almost all of them occur among the policemen and firemen who must return to him for subsequent treatment. The Philadelphia General Hospital is the dumping ground for fracture failures.

Regarding Doctor Walkling's remarks concerning the use of the fracture box, it is Doctor Owen's personal belief that the fracture can be treated equally as well with a pillow splint. Far too often the fracture box is used for fracture of both bones of the lower leg, a procedure which is inexcusable. He wished to emphasize again the importance of a weight-bearing splint for fractures of both bones of the lower leg. In the past two years he has had thirteen cases of fractures of both bones of the lower leg occurring among the motorcycle patrolmen. Several of these were severe compound fractures. As soon as is feasible these men are allowed to employ weight bearing with an ambulatory splint and there has been no case of delayed union or non-union.

DR DAMON B PREIFFER remarked that with due deference to the methods so carefully described by Doctor Walkling, and granting that with care excellent results can be obtained by this plan, he still feels that the time has come to discard the fracture box. The profession has now pretty well agreed that fractures call for immediate definitive treatment and in our hospital work it is uncommon not to be able to treat fractures of the leg on this principle, the exceptions being the presence of complicating injuries and poor general condition and those cases received too late for effective primary treatment. Some form of plaster case can be employed at once in the majority of fractures of the leg unless there has been large vessel injury with immediate and excessive swelling. In the ordinary case the danger of constriction by circular case has been greatly exaggerated. Still it exists and requires discretion and observation on the part of the surgeon. No method is fool proof so that the necessity for care and adequate precaution cannot be alleged as a contra-indication for the use of a method which gives the best result in competent hands. Only by proper fixation can good position be maintained. The expert use of plaster best fulfills this indication. While the speaker already indicated that he does not share the fear of circular casings, it is nevertheless true that at times the Delbet plan of splinting or the incorporation of pins for skeletal traction in the case are productive of results superior to the ordinary circular case. When these dressings are inapplicable, he confesses to a preference for the pillow splint over the fracture box. It is often possible to secure and maintain excellent reduction by the pillow splint in fractures of the lower portion of the leg, especially the Potts' fracture. It is more comfortable than the box and its soft elastic pressure tends to distribute and reduce the swelling.

FRACTURES OF THE SHAFT OF THE HUMERUS

Now in regard to primary closure of compound fractures It is true that in competent hands excellent, even brilliant results, are usually obtained, especially in fractures received in industrial plants where anaerobic organisms are not plentiful It is equally true that in street and farm wounds, this method, however and by whomsoever carried out, is dangerous and that the serious nature of the failures more than counterbalances one's brilliant successes There is a factor here which is uncontrollable by the surgeon, namely, the possibility of contamination of devitalized tissues and spaces by highly virulent organisms, and debridement, while it lessens the danger of infection, does not always prevent it One does not need to mention the serious consequences to life and limb entailed by infection of a closed compound fracture

For a number of years Doctor Smyth and the speaker have been greatly interested in the Orr plan and our results have been greatly improved We have now had about 145 cases There has been no disaster attributable to the method There has been no tetanus or gas gangrene There have been no deaths One leg has been lost, that of an extensive compound fracture dislocation of the ankle in which the circulation was compromised and at the operation the joint could not be entirely closed Gangrene and infection resulted and amputation was required but the patient survived with a good lower leg stump Doctor Pfeiffer felt that he must restrain himself from speaking too enthusiastically of the Orr method for he is aware that there are many surgeons who do not welcome or actually oppose this plan of treatment We can only say that in our hands it has seemed to solve the problems of compound fractures in most locations

FRACTURES OF THE SHAFT OF THE HUMERUS

DR CALVIN M SMYTH, JR, read a paper with the above title for which see page 1013

DR V W MURRAY WRIGHT said it would be better for humanity if bones were rectangular on cross section rather than circular X-ray pictures of a fracture are usually confined to the local site and rarely take in the entire length of the long bone which would permit a comparison of the planes at either end This latter procedure would enable one to determine readily if internal or external rotation had occurred Consequently, the use of the Jones' humerus traction splint may result in a limitation of external rotation in a healed fracture case because the lower fragment of the humerus was internally rotated as the forearm swung across the chest As internal (or external) rotation of a round bone cannot be observed ordinarily in a roentgenogram it is necessary for us to watch out for and pick it up clinically

DR BENJAMIN LIPSHUTZ said that in the reduction of supracondylar fractures, traction is best carried out with the elbow flexed and the forearm in position of pronation In this way one can relax the pronator and other muscles arising from the medial epicondyle of the humerus, frequently a good reduction is not obtained unless the pronator is relaxed

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Some fractures of the humerus following reduction are well maintained by a plaster bandage from the wrist to axilla with forearm flexed to a right angle. A ring of wire is incorporated in the upper side of the cast at the wrist, and through this the suspending sling is threaded which prevents the sling from sliding. This treatment does not immobilize but restricts motion, and weight of the case applies traction while the patient is standing or sitting.

DR L. K. FERGUSON said that in his experience reductions of the fracture of the shaft of the humerus were much easier if the patient be allowed to sit up during the reduction. In this position the weight of the arm is often sufficient to overcome shortening and produce reduction. When this position is employed in conjunction with the aid of the fluoroscope and local anesthesia reduction is often a simple matter. The cooperation of the patient under these conditions makes it much easier to apply the dressing and gives more satisfaction after application.

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